Class

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CHICAGO PUBLIC SCHOOLS

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REPORT ON

Child-Study Investigation

(March, 1899, to June 23, 1899)

BY

W. S. CHRISTOPHER, M. D.

REPRINT FROM THE ANNUAL REPORT OF THE

BOARD OF EDUCATION

OF CHICAGO :::1898-1899

JOHN F. HIGGINS, PRINTING AND BINDING
196 AND 198 CLARK STREET
CHICAGO, ILL.

L.B1103
.C5

By transfer
AUG 23 1910

CHICAGO PUBLIC SCHOOLS

Report of the

Department of Child-Study and Pedagogic Investigation

(July 1899 to July 1900)

CONTAINING THE REPORT OF THE COMMITTEE AND REPORT OF DIRECTOR FRED W. SMEDLEY

Reprint from the Forty-Sixth Annual Report of the Board of Education of Chicago, 1899-1900

Child-Study Report No. 2.

JOHN F. HIGGINS PRINT 196-198 CLARK STREET

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REPORT ON
CHILD STUDY INVESTIGATION

Graham H. Harris Esq., President Board of Education:

DEAR SIR—I submit herewith the report of the child study investigation done in certain of the Chicago Public schools, under my direction, during the last four months of the school year.

HISTORICAL.

At a meeting of the Committee on Physical Culture held early in February, 1899, I presented to the committee a plan for making some anthropometric observations on children in the public schools. This plan met with the approval of the committee, which recommended to the Board the appointment of two assistants to carry out the work. At its meeting of February 8, 1899, the Board adopted the recommendation of the committee. The assistants secured were Mr. C. Victor Campbell, a principal in one of the evening schools, and a man well posted in child study work, and Mr. Fred. W. Smedley, who was unusually well qualified for the work contemplated. Mr. Smedley, at the time, was a teacher of child study in the University of Chicago, and for several years had been actively engaged there in laboratory work in physiological psychology, as well as having done special work with the pupils in Prof. John Dewey's model school. Among other things Mr. Smedley had made some modifications in Mosso's ergograph, which especially adapted it to the work in hand. On February 21, 1899, the Board, on the recommendation of the Committee on Physical Culture, appointed these two gentlemen to carry on the work, and also appropriated $150.00 for the purchase of apparatus. On March 6, 1899, the work was begun in the Alcott School. This school was selected because it contained what may be called normal children. The pupils of this school are children of people in comfortable circumstances and are uniformly well fed and well clothed. The great majority of the pupils in this school are of

American birth, and there is no large percentage of any foreign nationality to introduce any disturbing factors of a racial or national type. It is believed that the pupils of this school represent normal American children.

After the completion of the work in the Alcott School the Burr School was visited, where the children in the kindergarten were examined. Later, examinations were made in the Thomas Hoyne School of kindergarten pupils and of two rooms of eighth grade pupils. The Alcott School has no kindergarten. Twenty pupils in an ungraded room were also examined.

GENERAL DESCRIPTION OF THE WORK.

The scope of the investigation may be seen from the following card, upon one of which the results of the tests were recorded, for each individual pupil:

No.....
Name.....Sex.....
School.....Grade.....
Teacher.....

Birthday—Year.....Month.....Day.....
Age—Years.....Months.....Days.....
School standing.....
Attention .....
Memory.....
Grasp of work .....
Best work is in .....
Deportment.....

Date		
Height with shoes		
Height of heel		
Net height		
Height sitting		
Weight with clothes		
Weight of clothing, est		
Net weight, est		
Ergograph—Hour		
Weight used		
Centimeters traveled		
Work—Centm. grams		
Fatigue commences—sec		
Duration of work		
Dynamometer, R		
do L		
Lung capacity		
Audiometer, R		
do L		

With certain special cases a wider range of tests was made, chiefly with the idea of helping the teacher to a more positive knowledge of the individual pupil.

The pupils were eager to take the tests and entered into the work with much the same spirit they would show in competitive games.

HEIGHT.

The measurements in height were taken by means of the stadiometer used in the Bertillon system of measuring. This instrument was graded to millimeters. In measuring the height standing, care was taken to see that the subject placed the heels together and against the middle ot the back of the stadiometer, that the body was held erect, that the chin was drawn in, the back of the head was against the upright back of the stadiometer, and that the arms hung by the sides. Measurements were taken with the shoes on. The heels were carefully measured by means of calipers and their height deducted from the gross height of the child. In a number of test measurements taken in this manner and then taken with the shoes removed, the greatest individual variation was but two millimeters, while the average variation was less than a single millimeter.

The height sitting was taken by means of the same instrument. The subject was seated on the base of the stadiometer. Care was taken to see that the body was held erect against the back of the stadiometer.

WEIGHT.

The weight of the pupils was taken on a specially made and carefully tested pair of Fairbank's bathroom scales. The scales were graded to twenty-five gram divisions. The pupils were weighed in their ordinary school room clothing. About one-tenth of the pupils—121 in number—brought back their clothing to be weighed, so that their exact net weights could be obtained, and the weight of their clothing could be made the basis for estimating the weight of the clothing of the others.

The weight of the ordinary school room clothing, taken chiefly in the latter part of the month of May, ranged between the extremes of two and eight-tenths per cent and eight and two-tenths per cent of the gross weight of the pupil. The average weight of the clothing for all the pupils was five and five-tenths per cent of the gross weight. The boys' clothing was five and eight-tenths per cent of the entire weight; that of the girls' was five and two-tenths per cent of the gross weight. These figures varied very little with age. The number of children was small whose clothing weighed over seven per cent of the body weight, and still smaller whose clothing went under four per cent. Obese children wore clothing lighter in proportion to their weight than that worn by others. The most vari-

able element in the weight of the clothing was found to be the shoes, and especially the shoes worn by the boys.

STRENGTH.

The strength of the grip in each hand was tested by means of a two-spring grip dynamometer. The instrument used is smaller in diameter than the ordinary dynamometer and so better suited to the hands of the pupils tested. This manuometer was carefully graded in kilograms, and was tested from time to time to see that it did not lose its accuracy through the weakening of the springs. Readings were made to half-kilograms. The subject was allowed in this test to try again and again until he fell short of the best record he had made.

THE ERGOGRAPH.

Mosso's ergograph, as modified by Mr. F. W. Smedley, paved the way for the study of the phenomena of fatigue and endurance. The apparatus consists of two parts, a fixing board, and a traveler mounted on a suitable frame. The forearm is placed upon the fixing board in the prone position, and held in place by suitable straps and clamps. There are also clamps to hold down the index and third fingers leaving the middle finger free. It is the design of the apparatus to hold the forearm so firmly in position that only the flexors of the middle finger can be brought into action. This it does not accomplish perfectly, but as the error is common to all those examined, the influence of the error is practically eliminated in comparative results. From the traveler two cords extend, one toward the fixing board, carrying a clamp to attach it to the free middle finger of the subject examined; the other, extending in the opposite direction over a pulley, is provided with a device for holding weights. Attached to the traveler and extending laterally, is an arm which carries a pen, which, in its turn, bears upon the surface of the drum of a kymograph. Attached to the side of the frame is an endless tape, which is carried forward with each return movement of the traveler, and thus sums up the total height which the weight has been lifted. The ergograph was operated in the following manner: The child's forearm being clamped in position, the cord from the traveler was clamped to its middle finger, and the pulley cord loaded with a weight equal to 7 per cent of the weight of the child. On flexing the finger, the weight was lifted, and the pen made a corresponding mark upon the kymograph. On extending the

finger the traveler dropped back to its original position, the measuring tape was advanced a distance equal to the height the weight had been raised, and the return stroke on the kymograph was made. By the aid of a metronome these flexions and extensions of the finger were made each second, so that in 90 seconds, the time employed in each experiment, the weight should be lifted 45 times. The actual number of lifts, however, varied occasionally from this number, reaching 48 or 49 in some instances, and not quite equalling 45 in others. In all cases, however, the work was continued for 90 seconds, and the amount of work done in centimeter-kilograms recorded. In the case of very obese children it is to be noted that 7 per cent of the total weight, including as it did 7 per cent of the weight of the fat, as well as 7 per cent of the weight of the active tissues of the body, proved to be excessive, and they were unable to continue to move the weight throughout the whole period of 90 seconds. Nevertheless the actual work done came out in the centimeter-kilograms, and was suitable for comparisons.

The ergogram, or tracing, as Mosso pointed out, is characteristic for each individual. It affords some ground for estimating the physical condition of the individual. The ergograms shown in Charts I and II illustrate something of this individual difference. One is that of an adult whose muscles are well controlled; the other is that of a so-called "nervous" child, one whose inhibition is defective, and whose efferent nerve impulses are erratic. The want of muscular control is shown by the irregularity in the heights of the lifts, the uneven spacing and the excessive number of lifts, showing the failure to keep time with the metronome.

CHART I.

2:00 P. M. 3.7 kg. 150 cm. 46 lifts.

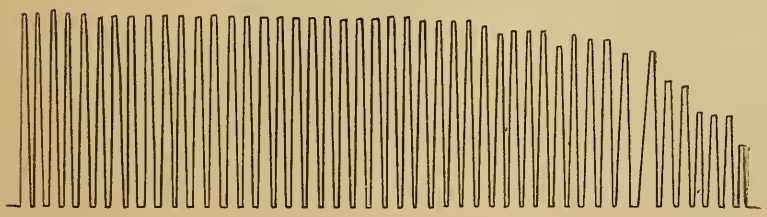
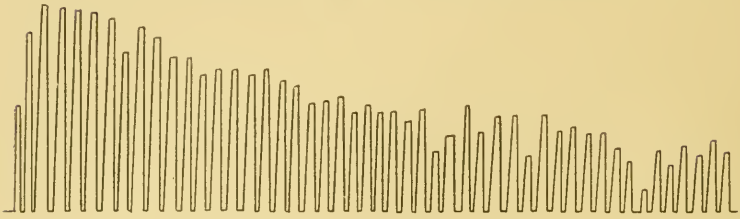


CHART II.

2.20 P. M. 3.9 kg. 92 cm. 49 lifts.



VITAL CAPACITY.

In dealing with the amount of air one can expire after a full inspiration, the old term vital capacity has been used. In the tests of vital capacity a specially prepared wet spirometer was employed. This was carefully graded, the scale reading to twenty-five cubic centimeters. In this test the subject was allowed repeated trials, until he fell short of his former endeavors. The aim of those making the test was to get the best record that it was possible for each pupil to make.

HEARING.

Hearing was tested by means of the audiometer recently invented by Dr. C. E. Seashore of the Iowa State University. The instrument is well adapted to school tests; and, by means of it, it was possible to grade the pupils in the matter of hearing in a manner that must have proved helpful to their teachers.

It will be of general interest to note that there is an increase with advancing age in the number of children who are hard of hearing. The number of pupils whose hearing is so far subnormal in one or both ears as to place them at a disadvantage, increased from six per cent among the six-year-old pupils to thirty-three per cent among those fourteen years old.

TABLES AND CHARTS OF NORMS.

An important part of the work of this investigation was the establishing of a series of norms or averages. These are given in the following tables; and that the results may appear more quickly to the eye the matter has been charted. Certain minor irregularities in these lines are probably due to the small number of subjects tested. It is hoped that in the future a larger collection of data may be made the basis of a more adequate discussion.

Table I, gives the norms determined in all the observations. Charts III to VII inclusive are drawn from the figures given in the table.

TABLE I.—NORMS.

	Age at Last Birthday.	Number Examined.	Average Age.			Standing Height. Millimeters.	Sitting Height. Millimeters.	Weight with Clothing. Kilograms.	Work on Ergograph Kilograms. Centimeters.	Strength of Grip.		Vital Capacity. Cubic Centimeters.
			Years.	Months.	Days.					Right Hand. Kilograms.	Left Hand. Kilograms.	
Girls	4	21	4	8	1	1,011	580	15.350	.....	5	4	800
Boys	4	16	4	7	18	1,008	583	16.638	.....	5	4	725
Girls	5	37	5	8	7	1.067	605	18.225	.....	7	6	900
Boys	5	26	5	6	2	1,071	606	17.983	.....	6.5	5	938
Girls	6	40	6	5	20	1,127	628	19.600	79	7.5	7	1,000
Boys	6	54	6	6	10	1,142	637	20.625	101	9	8	1,175
Girls	7	45	7	5	24	1,178	649	21.225	112	9	8	1,150
Boys	7	52	7	6	7	1,183	657	22.363	139	10	9	1,250
Girls	8	66	8	7	7	1,242	674	24.500	144	10	9	1,250
Boys	8	73	8	5	18	1,245	674	24.950	171	12	11	1,388
Girls	9	56	9	7	9	1,288	693	27.288	178	12	11.5	1,313
Boys	9	46	9	6	14	1,282	695	26.988	197	13	12	1,475
Girls	10	58	10	5	9	1,325	705	29.113	180	12.5	12	1,450
Boys	10	70	10	7	0	1,329	714	29.638	237	16	14	1,625
Girls	11	65	11	6	4	1.389	744	31.875	218	16	15	1,575
Boys	11	61	11	6	8	1,382	728	32.075	263	18	17	1,775
Girls	12	69	12	4	27	1,440	763	35.500	230	19	17	1,688
Boys	12	69	12	6	27	1.437	750	36.075	312	22	20	1,963
Girls	13	51	13	7	1	1,525	808	41.200	296	22	20.5	1.825
Boys	13	59	13	5	27	1,496	779	41.350	366	27	24	2,250
Girls	14	50	14	5	27	1,562	820	46.363	326	24	22	2,025
Boys	14	47	14	5	15	1,574	808	46.850	434	30	28	2,513
Girls	15	31	15	5	4	1,564	834	47.350	340	27	23.3	2,150
Boys	15	28	15	5	19	1,609	830	39.650	452	36	33	2,688
Girls	16	14	16	4	20	1,560	844	48.988	398	32.8	26.7	2,275
Boys	16	8	16	4	27	1,675	879	50.850	588	44.7	37	3,125

CHART III.

HEIGHT, STANDING AND SITTING.

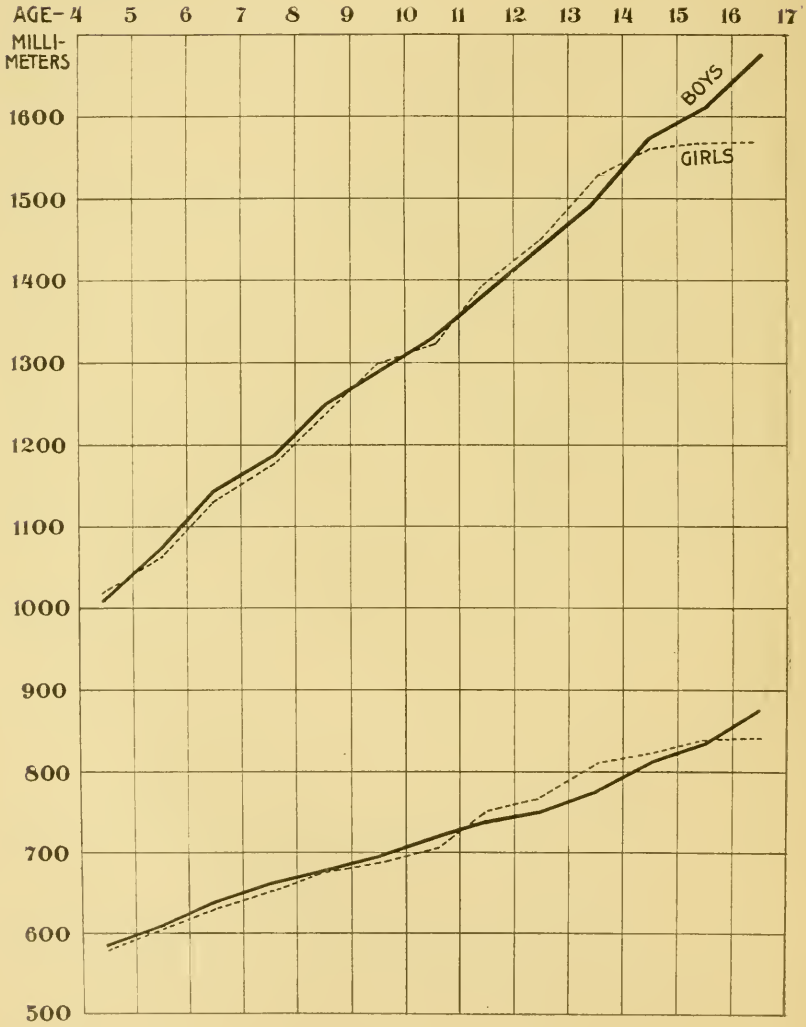


CHART IV.

Weight with Clothing.

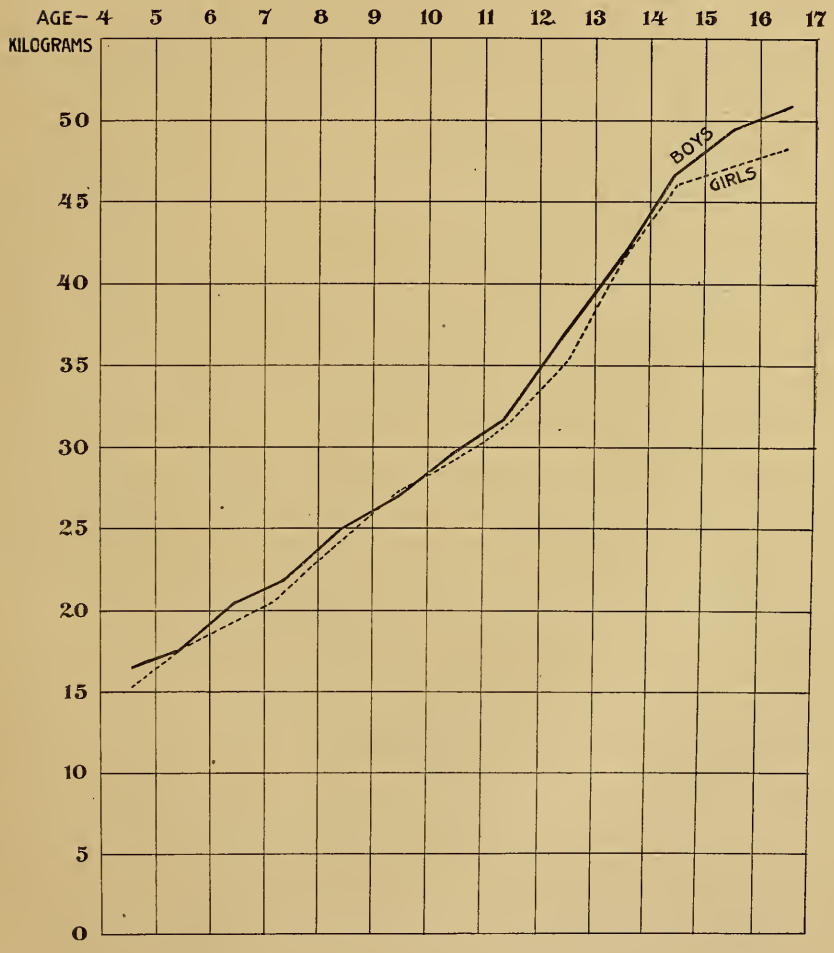


CHART V.

WORK ON THE ERGOGRAPH.

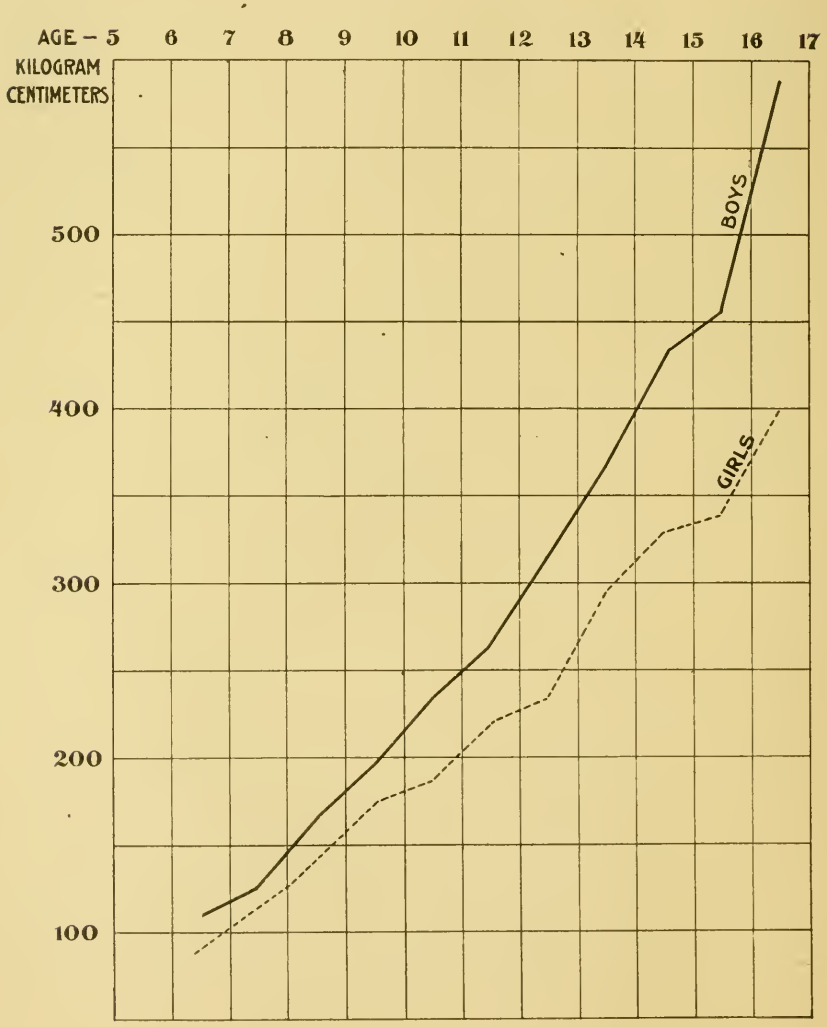


CHART VI.

Vital Capacity.

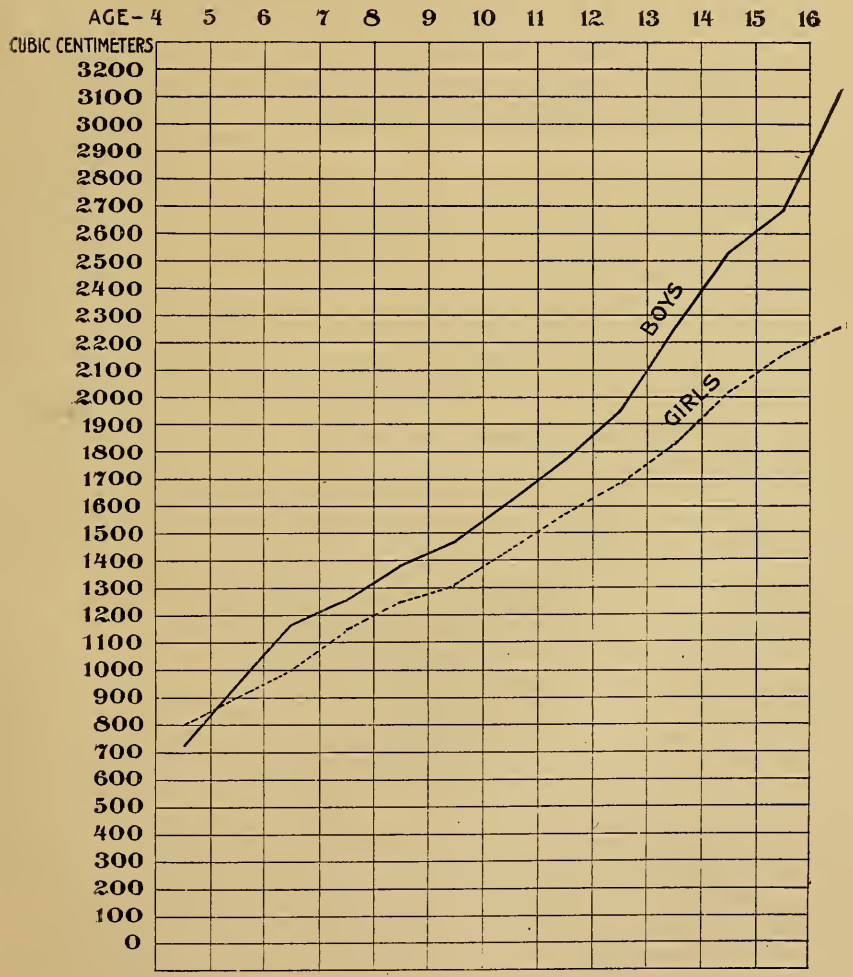
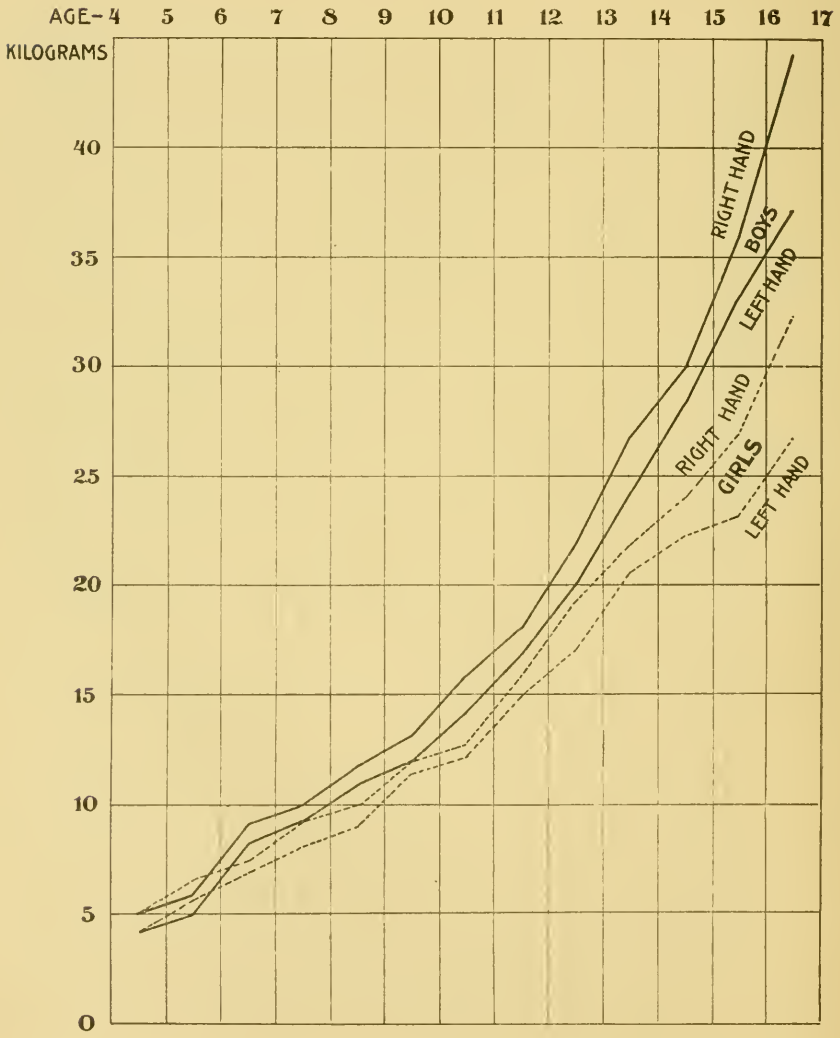


CHART VII.

STRENGTH OF GRIP.



The foregoing tables and charts afford some interesting information. The tables and charts relating to height standing, height sitting, and weight with clothing, although so much work has already been done in these lines, are important to us as they relate to Chicago children. Their particular utility, however, in this investigation is shown later in some of the comparative tables and charts.

On examining Chart V, on "Work on the Ergograph," it is found that the girls are everywhere below the boys in endurance, that this difference is nearly constant during the first four years of school life, and that after the age of nine the divergence between the sexes increases, the boys increasing in endurance more rapidly than the girls. Tabulating the differences in ergographic work for the different ages gives the following:

TABLE II

Age.	Superiority of Boys in Cen. Kg.	Age.	Superiority of Boys in Cen. Kg.
6	22	12	82
7	17	13	70
8	27	14	108
9	19	15	112
10	57	16	190
11	41		

This table alone is rather misleading, but reduced to percentages gives the following:

TABLE III.

Age.	Percentage Girls' Endurance is of Boys'.	Age.	Percentage Girls' Endurance is of Boys'.
6	79	12	74
7	87	13	81
8	84	14	75
9	90	15	75
10	76	16	68
11	83		

On the average the girls' strength is 79 per cent of the boys'. If these results be true, they may have some bearing on the question of co-education and they would seem to indicate that somewhere in the upper grades, the sexes might with advantage to both be separated in instruction, and possibly larger demands made of the boys. In this connection it must

be said, however, that the total number of pupils examined, is too small to warrant hard and fast conclusions being drawn. The "Vital Capacity" chart, like the ergographic chart, indicates increasing divergence between boys and girls, with increasing age, and to the advantage of the boys. The same condition is also illustrated by the grip chart. This chart also seems to indicate that marked differences in the strength of the two hands does not occur in boys until after 14 years, and in girls until after 13.

COMPARISON OF PHYSICAL AND INTELLECTUAL CAPACITY.

Some years ago Prof. W. Townsend Porter, then of St. Louis, now of Harvard Medical School, made anthropometric observations on a large number of children in the St. Louis schools. Among his observations was one to the effect that the brighter children in a room had a greater mean weight than the mean weight of the whole room, from which he formulated the dictum that intellectual capacity in school children is a function of body weight. Although this conclusion of Porter's has been much criticised, it has always appeared to me to be one of great importance. At the outset, therefore, of these tests I determined to re-investigate Porter's problem, and to that end put at the top of each card certain data to be supplied by the teacher with reference to each pupil, and comprising marking on a scale of 10 in attention, memory, and grasp of work, from which it was thought a reliable average school standing could be computed, and subsequently used in comparison with the physical data obtained by the trained observers, Messrs. Smedley and Campbell. It was found, however, that on account of the range of age of the pupils in each room that a satisfactory presentation of the subject could not be made with the small number of pupils examined.

In place of the plan contemplated, one perhaps more reliable has been employed. The grading of the schools is entirely upon an intellectual basis, and the grade standing of a large group of pupils may be considered to indicate fairly their intellectual capacity. In the Alcott School there were 126 eleven-year-old pupils and 138 twelve-year-old pupils. The eleven-year-old pupils were scattered through the grades from the second to the seventh inclusive, and the twelve-year-old pupils were found in the third to the eighth grades.

These ages were selected because there were more pupils tested of these ages than any other. Then again the pupils of less age are not so widely distributed through the grades, and

if an age above twelve were taken it would be found that some had gone into the high schools and so were beyond the range of our present observation. Enough has been done with other ages to show that the law holds good.

The following tables, IV to XIII, and charts VIII to XII, show the physical peculiarities of these two groups of children in net height, weight with clothing, endurance (ergograph work), vital capacity, and strength of grip of the right hand. The fact that the charts give broken lines instead of smooth curves is probably due to the small number of pupils tested.

TABLE IV.

Mean height of the twelve-year-old pupils of the different grades:

GRADES.	No. Measured.	Mean Height in Millimeters.	Average Age.
III	1	1354	12 yrs. 2 mo. 7 da.
IV	19	1431	12 yrs. 4 mo. 28 da.
V	42	1407	12 yrs. 5 mo. 13 da.
VI	41	1441	12 yrs. 5 mo. 18 da.
VII	30	1475	12 yrs. 7 mo. 22 da.
VIII	5	1504	12 yrs. 6 mo. 27 da.

TABLE V.

Mean height of the eleven-year-old pupils of the different grades:

GRADES.	No. Measured.	Mean Height in Millimeters.	Average Age.
II	2	1314	11 yrs. 5 mo. 29 da.
III	4	1350	11 yrs. 7 mo. 7 da.
IV	44	1369	11 yrs. 5 mo. 16 da.
V	50	1382	11 yrs. 6 mo. 2 da.
VI	20	1427	11 yrs. 6 mo. 26 da.
VII	6	1474	11 yrs. 7 mo. 15 da.

CHART VIII.

NET HEIGHT.

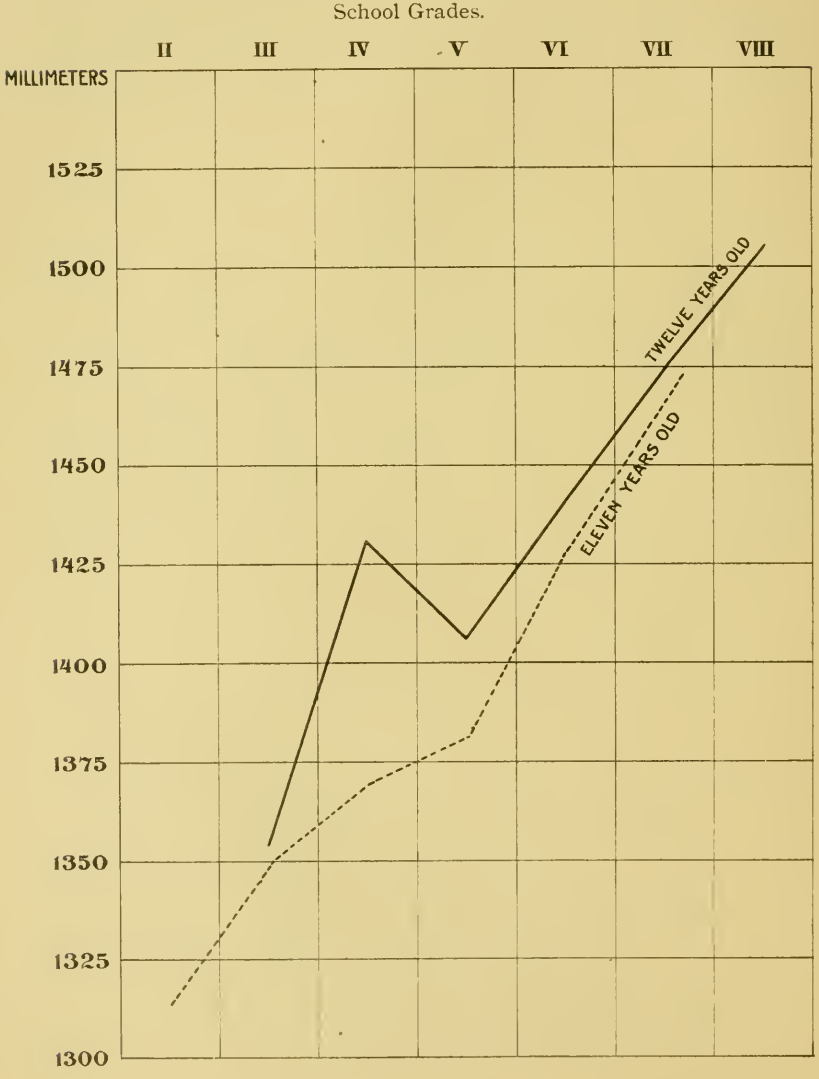


TABLE VI.

Mean weight with clothing of the twelve-year-old pupils of the different school grades:

GRADES.	Number Weighed.	Mean Weight in Kilograms.	Average Age.
III	1	28.125	12 yrs. 2 mo. 7 da.
IV	19	35.500	12 yrs. 4 mo. 28 da.
V	42	34.525	12 yrs. 5 mo. 13 da.
VI	41	34.450	12 yrs. 5 mo. 18 da.
VII	30	37.788	12 yrs. 7 mo. 22 da.
VIII	5	42.025	12 yrs. 6 mo. 27 da.

TABLE VII.

Mean weight with clothing of the eleven-year-old pupils of the different school grades:

GRADES.	Number Weighed.	Mean Weight in Kilograms.	Average Age.
II	2	28.613	11 yrs. 5 mo. 29 da.
III	4	30.400	11 yrs. 7 mo. 7 da.
IV	44	31.788	11 yrs. 5 mo. 16 da.
V	50	31.512	11 yrs. 6 mo. 2 da.
VI	20	35.850	11 yrs. 6 mo. 26 da.
VIII	6	40.225	11 yrs. 7 mo. 15 da.

CHART IX.

WEIGHT WITH CLOTHING.

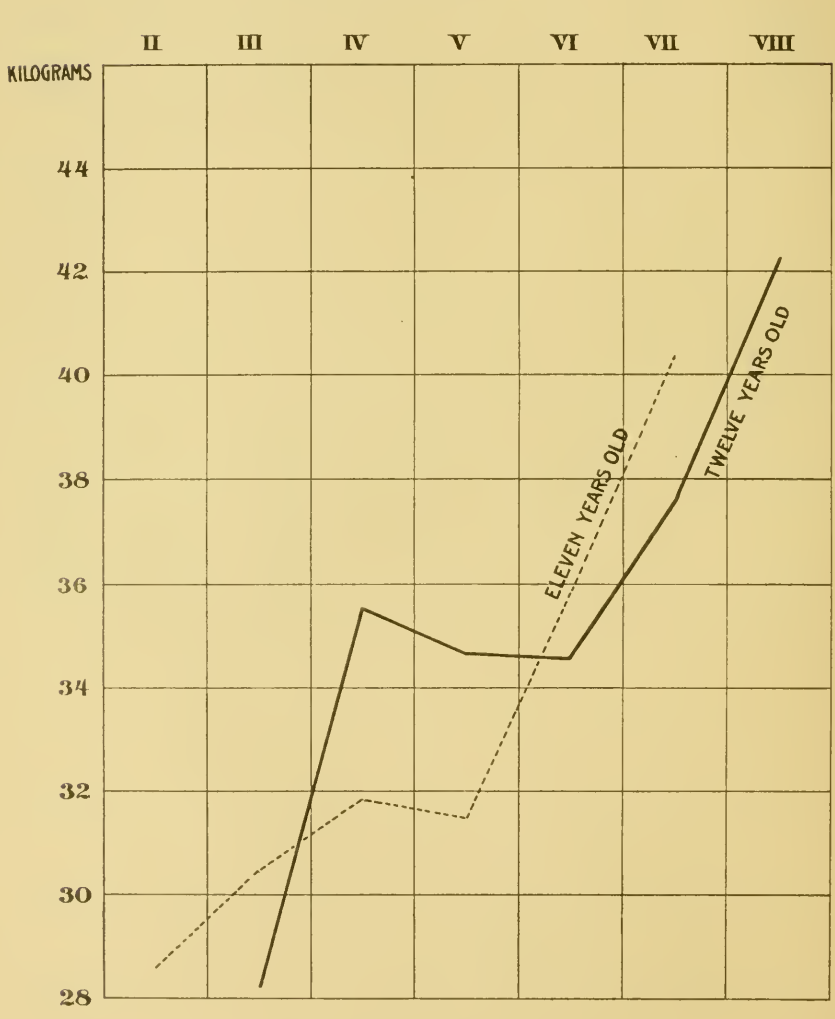


TABLE VIII.

Mean work done on the Ergograph in ninety seconds by the twelve-year-old pupils of the different school grades:

GRADES.	No. Tested.	Work done in Cent. Kgs.	Average Age.
III	1	246	12 yrs. 2 mo. 7 da.
IV	19	307.4	12 yrs. 4 mo. 28 da.
V	42	270.1	12 yrs 5 mo. 13 da.
VI	41	271.2	12 yrs. 5 mo. 18 da.
VII	30	302.4	12 yrs. 7 mo. 22 da.
VIII	5	318	12 yrs. 6 mo. 27 da.

TABLE IX.

Mean work done on the Ergograph by eleven-year-old pupils of the different school grades:

GRADES.	No. Tested.	Work done in Cent. Kgs.	Average Age.
II	2	173	11 yrs 5 mo. 29 da.
III	4	195	11 yrs. 7 mo. 7 da.
IV	44	245.6	11 yrs. 5 mo. 16 da.
V	50	237.8	11 yrs. 6 mo. 2 da.
VI	20	269.3	11 yrs. 6 mo 26 da.
VII	6	302	11 yrs. 7 mo. 15 da.

CHART X.

Work with Ergograph.

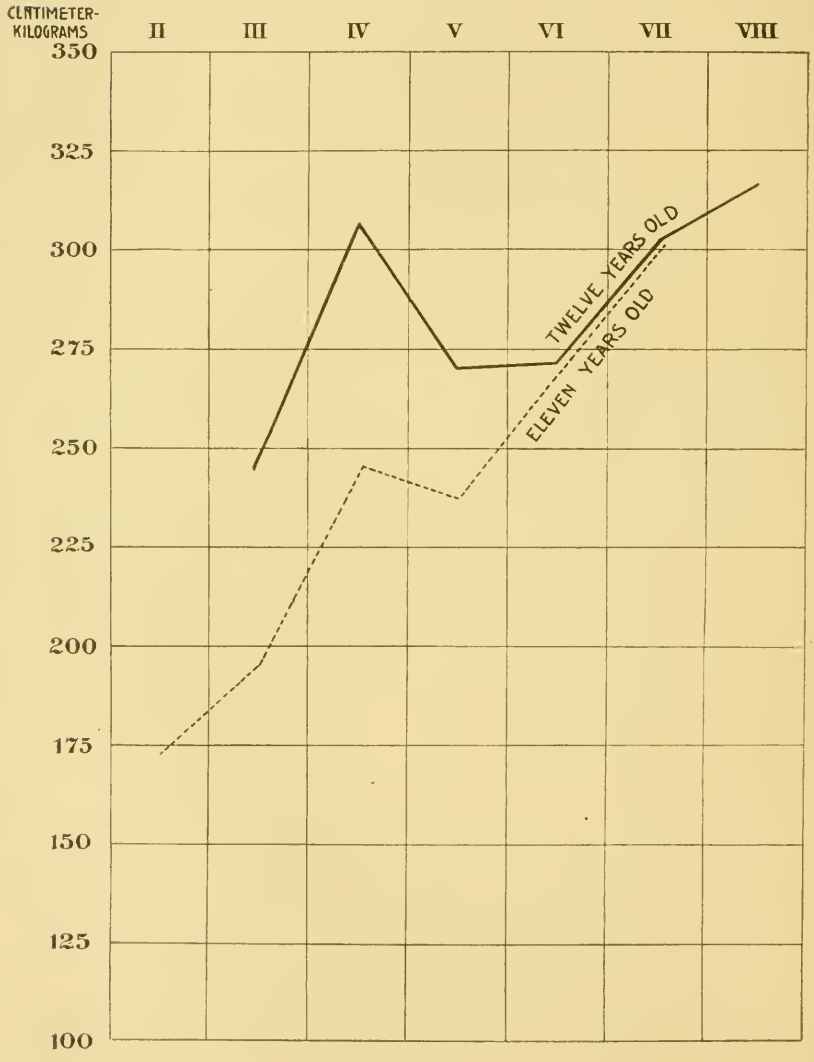


TABLE X.

Mean vital capacity of the twelve-year-old pupils of the different school grades:

GRADES.	No. Tested.	Vital Capacity in Cub. Cent's.	Average Age.
III	1	1700	12 yrs. 2 mo. 7 da.
IV	19	1650	12 yrs. 4 mo. 28 da.
V	42	1763	12 yrs. 5 mo. 13 da.
VI	41	1925	12 yrs. 5 mo. 18 da.
VII	30	1863	12 yrs. 7 mo. 22 da.
VIII	5	2400	12 yrs. 6 mo. 27 da.

TABLE XI.

Mean vital capacity of the eleven-year-old pupils of the different grades:

GRADES.	No. Tested.	Vital Capacity in Cub. Cent's.	Average Age.
II	2	1400	11 yrs. 5 mo. 29 da.
III	4	1588	11 yrs. 7 mo. 7 da.
IV	44	1650	11 yrs. 5 mo. 16 da.
V	50	1638	11 yrs. 6 mo. 2 da.
VI	20	1850	11 yrs. 6 mo. 26 da.
VII	6	1675	11 yrs. 7 mo. 15 da.

CHART XI.

Vital Capacity.

School Grades.

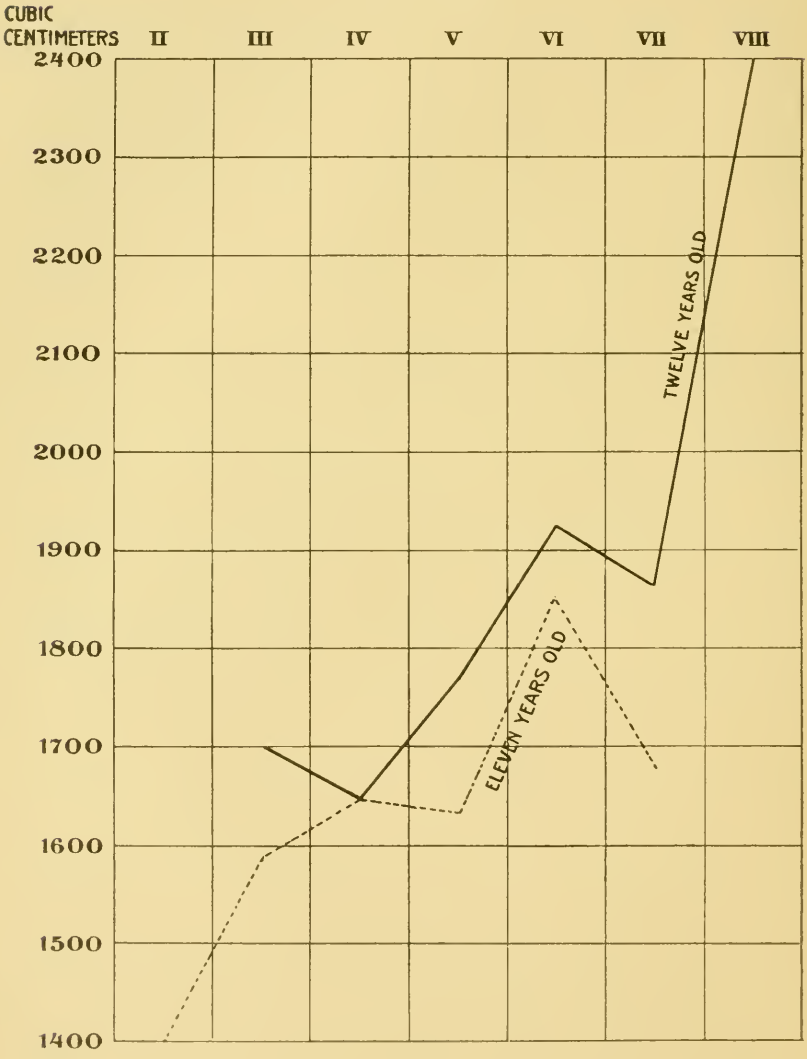


TABLE XII.

Mean strength of grip of the right hand of the twelve-year-old pupils of the different school grades:

GRADES.	No. Tested.	Strength in Kilograms.	Average Age.
III	1	12	12 yrs. 2 mo. 7 da.
IV	19	18	12 yrs. 4 mo. 28 da.
V	42	19.5	12 yrs. 5 mo. 13 da.
VI	41	21	12 yrs, 5 mo. 18 da.
VII	30	20	12 yrs. 7 mo. 22 da.
VIII	5	25	12 yrs. 6 mo. 27 da.

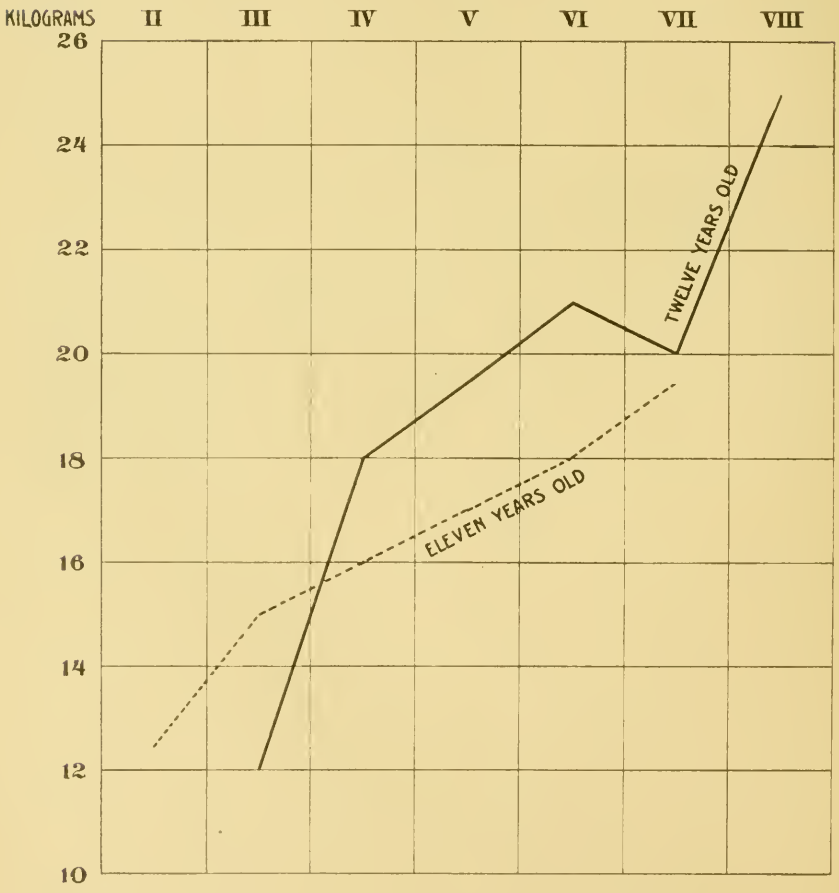
TABLE XIII.

Mean strength of grip of the right hand of the eleven-year-old pupils of the different school grades:

GRADES.	No. Tested.	Strength in Kilograms.	Average Age.
II	2	12.5	11 yrs. 5 mo. 29 da.
III	4	15	11 yrs. 7 mo. 7 da.
IV	44	16	11 yrs. 5 mo. 16 da.
V	50	17	11 yrs. 6 mo. 2 da.
VI	20	18	11 yrs. 6 mo. 26 da.
VII	6	19.5	11 yrs. 7 mo. 15 da.

CHART XII.

STRENGTH OF RIGHT HAND.



It is clear from the foregoing charts and tables, that on the average those pupils who have made great intellectual advancement are on the whole taller, heavier, stronger, possessed of greater endurance, and larger breathing capacity than those who have made less advancement. These observations also indicate that a physical factor, as well as the intellectual one now entirely relied upon, should be introduced in the grading of pupils. This physical factor is particularly desirable in determining the fitness of children to enter the first grade, where so many children under the legal school age, are entered by misguided parents to the great detriment of the children.

In this connection, mention must be made of a fact well-known to all. In every school there are a few pupils who are small in stature and light in weight, and yet exceedingly bright in their school work. It is not very uncommon to find that the best pupil in the room is the smallest, and possibly the youngest, These small bright pupils constitute a class by themselves, they are exceptions to the general rule, and must, like all exceptions, receive special consideration. Such children cannot be considered normal, and I venture the assertion that the true explanation of them will be found to be of greater medical than pedagogical interest.

PHYSICAL EXTREMES IN EACH ROOM.

In Table XIV. are given the extremes in height, height sitting, weight with clothing, work on the ergograph, grip of right hand, and vital capacity in each of the several rooms examined — in all, twenty-eight rooms. These figures, as to the twenty-four rooms in the Alcott School are graphically represented in charts XIII. to XVII.

Chart XIII. giving extremes in height, shows that the tallest pupil in the first grade is but very little shorter than the shortest pupil in the eighth grade, the actual difference being only eighteen millimeters or less than three-quarters of an inch. Between these two grades the statures overlap each other in all the rooms. The greatest range of stature happens to be found in one of the fifth grade rooms, and amounts to 532 millimeters or twenty-one inches. I cannot conceive of a more eloquent plea for adjustable desks than this, and not only desks adjustable in name, but desks which can be actually adjusted. Chart XV, showing extremes of work on the ergograph, is most instructive. The divergence of the extremes of endurance in the first grade is comparatively

slight, showing that there the pupils are fairly evenly balanced in power, the minimum amounting to 28.3 per cent of the maximum. With each succeeding grade the divergence of the extremes increases until in the seventh grade the endurance of the weakest pupil amounts to only 18 per cent, and in the eighth grade to 18.5 per cent of that of the strongest. The chart shows the necessity of a very careful study of this problem, the determining of the causes of the phenomenon, and as far as possible removing these causes. Even before causes are determined the fact itself calls for greater elasticity in the work of the upper grades.

Charts XVI and XVII confirm the teachings of Chart XV. At present the work in physical culture is done by rooms; the rooms are graded on an intellectual basis exclusively. This is, on its face, bad for the work in physical culture, but how bad it is could not be known until such facts as those furnished by these tables of extremes had been worked out. If physical culture is to accomplish the most possible for the pupils of our schools, its classes must be graded upon a physical basis, and the work adapted to the needs of the pupil. It is believed that this can be done without too great interference with the other school work. Certainly these observations show the great necessity for the work of physical culture.

TABLE XIV.

VARIATIONS IN THE SAME SCHOOL ROOM.

Kindergarten Burr School. Sadie F. Smith, teacher.

	Lowest.	Highest.	Percentage. Lowest is of Highest.
Age	4.0:25	7:0:24	58
Height	922 mm.	1176 mm.	78
Height sitting	532 mm.	638 mm.	84
Weight (with clothing)	13.725 kg.	21.675 kg.	63
Grip of right hand	3 kg.	12 kg.	25
Vital capacity	600 ccm.	1100 ccm.	55

Table XIV—Variations in the Same School Room — Continued.

Kindergarten Hoyne School. Margaret Forsyth, teacher.

	Lowest.	Highest.	Percentage. Lowest is of Highest.
Age	3:5:9	6:5:1	54
Height	866 mm.	1141 mm.	76
Height sitting	502 mm.	636 mm.	79
Weight (with clothing)	12.900 kg.	21.775 kg.	59
Grip of right hand	3 kg.	10 kg.	30
Vital capacity	550 ccm.	1300 ccm.	42

First Grade Alcott School. Louisa Buhre, teacher.

Age	5:5:23	9:4:1	59
Height	1016 mm.	1259 mm.	81
Height sitting	572 mm.	696 mm.	82
Weight (with clothing)	15.875 kg.	27.300 kg.	58
Work on ergograph	40 kg. cm.	149 kg. cm.	27
Grip of right hand	5 kg.	18 kg.	28
Vital capacity	700 ccm.	1375 ccm.	51

First Grade Alcott School. Estelle Eckardt, teacher.

Age	5:5:7	8:8:18	62
Height	1031 mm.	1232 mm.	84
Height sitting	582 mm.	680 mm.	86
Weight (with clothing)	14.900 kg.	27.850 kg.	54
Work on ergograph	51 kg. cm.	153 kg. cm.	33
Grip of right hand	5 kg.	13 kg.	38
Vital capacity	700 ccm.	1475 ccm.	47

First Grade Alcott School. Edythe Olson, teacher.

Age	6:1:18	9 3:18	64
Height	1074 mm.	1322 mm.	81
Height sitting	585 mm.	737 mm.	79
Weight (with clothing)	15.350 kg.	36.250 kg.	42
Work on ergograph	53 kg. cm.	252 kg. cm.	21
Grip right hand	5 kg.	18 kg.	28
Vital capacity	950 ccm.	1500 ccm.	63

First Grade Alcott School. Mabel B. P. Inskeep, teacher.

Age	6:0:14	9:8:16	62
Height	1080 mm.	1282 mm.	84
Height sitting	586 mm.	701 mm.	84
Weight (with clothing)	17.525 kg.	28.575 kg.	61
Work on ergograph	59 kg. cm.	182 kg. cm.	32
Grip right hand	7 kg.	15 kg.	47
Vital capacity	900 ccm.	1800 ccm.	50

Table XIV—Variations in the Same School Room — Continued.

Second Grade Alcott School. Blanche Quinlan, teacher.

	Lowest.	Highest.	Percentage. Lowest is of Highest.
Age	7:3:14	9:1:9	80
Height	1119 mm.	1382 mm.	81
Height sitting	610 mm.	752 mm.	81
Weight (with clothing)	17.600 kg.	32 875 kg.	54
Work on ergograph	73 kg. cm.	290 kg. cm.	25
Grip right hand	6 kg.	18 kg.	33
Vital capacity	875 ccm.	1825 ccm.	48

Second Grade Alcott School. Rose A. Altschul, teacher.

Age	6:6:7	10:1:11	64
Height	1123 mm.	1340 mm.	84
Height sitting	604 mm.	735 mm.	82
Weight (with clothing)	18.325 kg.	62.200 kg.	29
Work on ergograph	92 kg. cm.	272 kg. cm.	34
Grip of right hand	7 kg.	18 kg.	39
Vital capacity	800 ccm.	1800 ccm.	44

Second Grade Alcott School. Marian Wilzinski, teacher.

Age	7:5:22	11:6:13	65
Height	1178 mm.	1364 mm.	86
Height sitting	640 mm.	734 mm.	87
Weight (with clothing)	19.125 kg.	35.150 kg.	54
Work on ergograph	53 kg. cm.	363 kg. cm.	15
Grip of right hand	8 kg.	23 kg.	35
Vital capacity	1000 cucm.	2000 ccm.	50

Second Grade Alcott School. Mabel H. Christie, teacher.

Age	8:0:19	10:7:24	76
Height	1167 mm.	1374 mm.	85
Height sitting	651 mm.	741 mm.	88
Weight (with clothing)	21.525 kg.	33.650 kg.	64
Work on ergograph	88 kg. cm.	268 kg. cm.	33
Grip of right hand	6 kg.	18 kg.	33
Vital capacity	1000 ccm.	1700 ccm.	59

Second Grade Alcott School. Hilma Enander, teacher.

Age	7:5:2	11:5:14	65
Height	1149 mm.	1350 mm.	85
Height sitting	620 mm.	721 mm.	86
Weight (with clothing)	19.825 kg.	34.225 kg.	58
Work on ergograph	99 kg. cm.	271 kg. cm.	37
Strength of right hand	7 kg.	21 kg.	33
Vital capacity	1000 ccm.	1875 ccm.	53

Table XIV—Variations in the Same School Room — Continued.

Third Grade Alcott School. Sara A. Ryan, teacher.

	Lowest.	Highest.	Percentage. Lowest is of Highest.
Age	7:9:11	11:1:19	70
Height	1166 mm.	1404 mm.	83
Height sitting	644 mm.	745 mm.	86
Weight (with clothing)	21.750 kg.	35.275 kg.	62
Work on ergograph	111 kg. cm.	314 kg. cm.	35
Grip of right hand	8 kg.	20 kg.	40
Vital capacity	1200 ccm.	2250 ccm.	53

Third Grade Alcott School. Laura McIntire, teacher.

Age	8:3:11	12:2:7	68
Height	1215 mm.	1470 mm.	83
Height sitting	663 mm.	775 mm	86
Weight (with clothing)	23.625 kg.	58.225 kg.	41
Work on ergograph	122 kg. cm.	314 kg. cm.	49
Strength of right hand	10 kg.	22 kg.	45
Vital capacity	1100 ccm.	2075 ccm.	53

Fourth Grade Alcott School. Amanda V. Anderson, teacher.

Age	8:2:13	12:5:24	65
Height	1164 mm.	1465 m m.	79
Height sitting	630 mm.	758 mm.	83
Weight (with clothing)	20.950 kg.	41.350 kg.	51
Work on ergograph	133 kg. cm.	342 kg. cm.	39
Strength of right hand	8 kg.	19 kg.	4.
Vital capacity	1000 ccm.	2025 ccm.	49

Fourth Grade Alcott School. Amanda Henderson, teacher.

Age	9:6:1	14:1:4	71
Height	1196 mm.	1523 mm.	79
Height sitting	672 mm.	818 mm.	82
Weight (with clothing)	21.700 kg.	54.800 kg.	40
Work on ergograph	130 kg. cm.	456 kg. cm.	29
Strength of right hand	9 kg.	28 kg.	32
Vital capacity	1125 ccm.	2400 ccm.	47

Fourth Grade Alcott School. Katherine Keir, teacher.

Age	9:4:10	14:6:0	65
Height	1201 mm.	1529 mm.	79
Height sitting	627 mm.	815 mm.	77
Weight (with clothing)	20 800 kg.	53.200 kg.	39
Work on ergograph	99 kg. cm.	420 kg. cm.	24
Strength of right hand	9 kg.	31 kg.	29
Vital capacity	1075 ccm.	2650 ccm.	41

Table XIV—Variations in the Same School Room — Continued.

Fourth Grade Alcott School. Fannie T. Farrell, teacher

	Lowest.	Highest.	Percentage. Lowest is of Highest.
Age	9:6:23	14:3:22	67
Height	1191 mm.	1528 mm.	78
Height sitting	635 mm.	818 mm.	78
Weight (with clothing)	20 775 kg.	50.400 kg.	41
Work on ergograph	128 kg. cm.	525 kg. cm.	24
Strength of right hand	10 kg.	27 kg.	37
Vital capacity	1075 ccm.	2600 ccm.	41

Fifth Grade Alcott School. Lillie A. Hussander, teacher.

Age	10:0:18	14:3:12	72
Height	1213 mm.	1574 mm.	77
Height sitting	665 mm.	814 mm.	82
Weight (with clothing)	23.200 kg.	46.775 kg.	50
Work on ergograph	108 kg. cm.	462 kg. cm.	23
Strength of right hand	10 kg.	29 kg.	34
Vital capacity	1275 ccm.	2875 ccm.	44

Fifth Grade Alcott School. Frances M. Silliman, teacher.

Age	10:7:12	15:8:0	68
Height	1245 mm.	1777 mm.	70
Height sitting	655 mm.	866 mm.	76
Weight (with clothing)	21.475 kg.	55.125 kg.	39
Work on ergograph	75 kg. cm.	587 kg. cm.	13
Strength of right hand	8 kg.	27 kg.	30
Vital capacity	1000 ccm.	2350 ccm.	43

Sixth Grade Alcott School. May A. Behan, teacher.

Age	9:10:19	14:7:11	68
Height	1260 mm.	1646 mm.	77
Height sitting	667 mm.	870 mm.	77
Weight (with clothing)	25 550 kg.	56.625 kg.	45
Work on ergograph	163 kg. cm.	628 kg. cm.	26
Strength of right hand	10 kg.	35 kg.	29
Vital capacity	1075 ccm.	2525 ccm.	42

Sixth Grade Alcott School. Elizabeth B. Parkes, teacher.

Age	9:9:0	15:8:16	62
Height	1345 mm.	1654 mm.	81
Height sitting	710 mm.	859 mm.	83
Weight (with clothing)	28.250 kg.	55.475 kg.	51
Work on ergograph	141 kg. cm.	646 kg. cm.	22
Strength of right hand	14 kg.	41 kg.	34
Vital capacity	1050 ccm.	3125 ccm.	34

Table XIV—Variations in the Same School Room — Continued.

Seventh Grade Alcott School. Fannie S. Roberts, teacher.

	Lowest.	Highest.	Percentage. Lowest is of Highest.
Age	11:5:24	15:8:8	73
Height	1333 mm.	1735 mm.	77
Height sitting	691 mm.	897 mm.	78
Weight (with clothing)	29.525 kg.	62 950 kg.	47
Work on ergograph	168 kg. cm.	744 kg. cm.	23
Strength of right hand	15 kg.	54 kg.	28
Vital capacity	1400 ccm.	3700 ccm.	38

Seventh Grade Alcott School. Jeanette L. Bacon, teacher.

Age	12:2:14	15:11:0	58
Height	1326 mm.	1702 mm.	78
Height sitting	692 mm.	902 mm.	77
Weight (with clothing)	30.600 kg.	59 025 kg.	52
Work on ergograph	153 kg. cm.	748 kg. cm.	21
Strength of right hand	14 kg.	41.5 kg.	36
Vital capacity	1425 ccm.	3525 ccm.	41

Seventh Grade Alcott School. Blanche C. Turner, teacher.

Age	11:3:12	16:4:14	69
Height	1267 mm.	1715 mm.	74
Height sitting	679 mm.	902 mm.	75
Weight (with clothing)	31.550 kg.	68.525 kg.	46
Work on ergograph	104 kg. cm.	1050 kg. cm.	10
Strength of right hand	12 kg.	55 kg.	21
Vital capacity	1350 ccm.	3650 ccm.	37

Eighth Grade Alcott School. Jessie A. Phelps, teacher.

Age	12:5:4	16:2:27	77
Height	1390 mm.	1728 mm.	75
Height sitting	711 mm.	932 mm.	76
Weight (with clothing)	31.775 kg.	72.325 kg.	44
Work on ergograph	154 kg. cm.	968 kg. cm.	16
Strength of right hand	17.5 kg.	46.5 kg.	38
Vital capacity	1300 ccm.	3825 ccm.	34

Eighth Grade Alcott School. Anna R. Burke, teacher.

Age	12:2:15	16:10 6	72
Height	1340 mm.	1738 mm.	77
Height sitting	705 mm.	889 mm.	79
Weight (with clothes)	30 625 kg.	72.550 kg.	42
Work on ergograph	142 kg. cm.	679 kg. cm.	21
Strength of right hand	14.5 kg.	40 kg.	36
Vital capacity	1500 ccm.	3275 ccm.	46

Table XIV—Variations in the Same School Room — Continued.

Eighth Grade Hoyne School. Annie G. Ahearn, teacher.

	Lowest.	Highest.	Percentage. Lowest is of Highest.
Age	13:10:17	17:8:21	78
Height	1407 mm.	1771 mm.	79
Height sitting	736 mm.	937 mm.	78
Weight (with clothing)	34.675 kg.	68.225 kg.	51
Work on ergograph	221 kg. cm.	920 kg. cm.	24
Strength of right hand	21 kg.	58 kg.	36
Vital capacity	1825 ccm.	4125 ccm.	44

Eighth Grade Hoyne School. S. Augusta Stimpson, teacher.

Age	13:4:0	17:11:15	74
Height	1428 mm.	1732 mm.	82
Height sitting	753 mm.	907 mm.	83
Weight (with clothing)	35.375 kg.	61.675 kg.	57
Work on ergograph	223 kg. cm.	802 kg. cm.	28
Strength of right hand	16 kg.	49 kg.	33
Vital capacity	1600 ccm.	3700 ccm.	43

CHART XIII.

DIFFERENCES IN HEIGHT BETWEEN THE TALLEST AND THE SHORTEST PUPIL OF EACH ROOM OF THE ALCOTT SCHOOL.

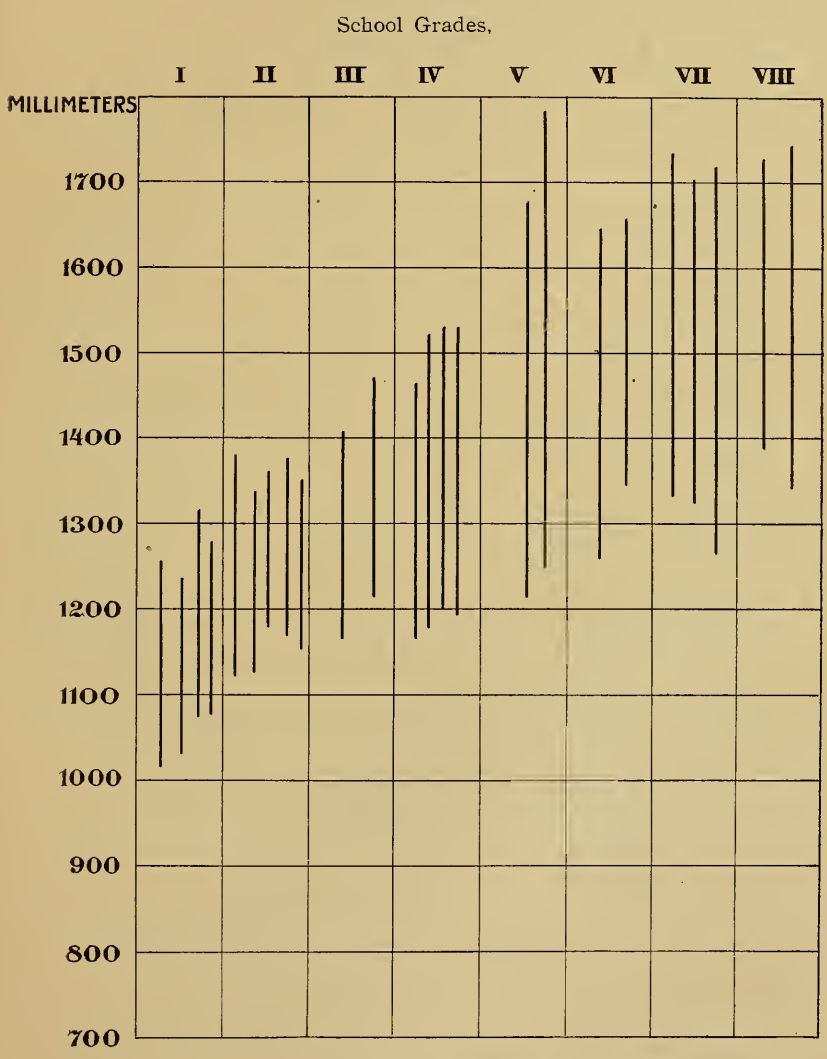


CHART XIV.

DIFFERENCES IN WEIGHT BETWEEN THE LIGHTEST AND HEAVIEST PUPIL OF EACH ROOM OF THE ALCOTT SCHOOL.

CHART XV.

EXTREMES OF WORK ON THE ERGOGRAPH.

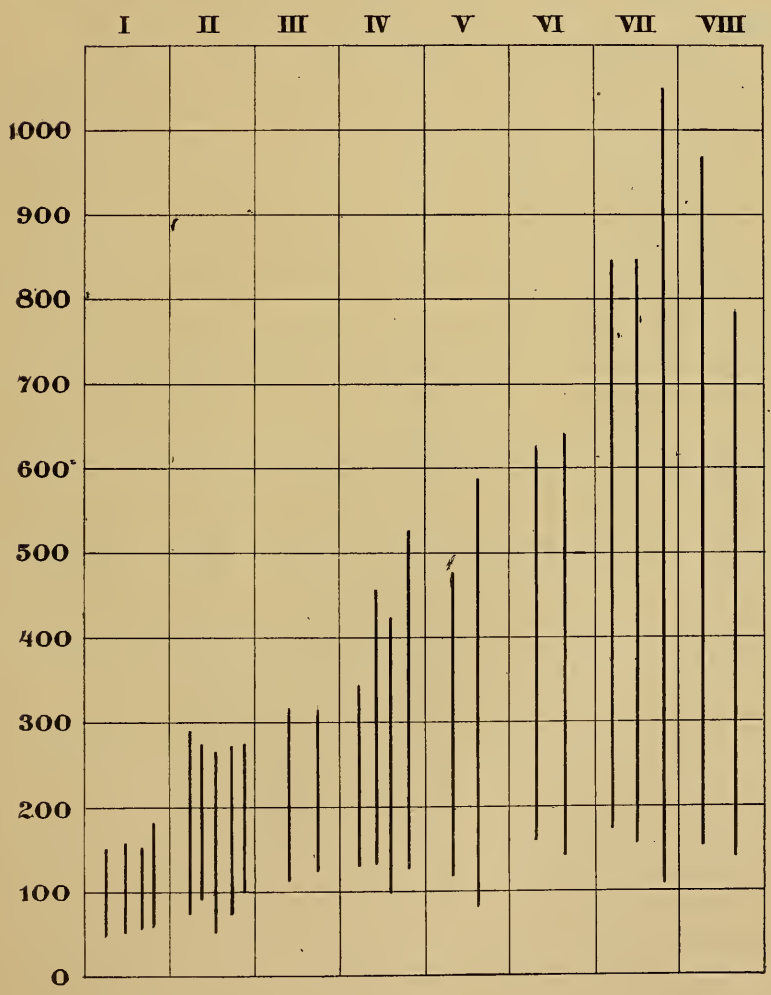
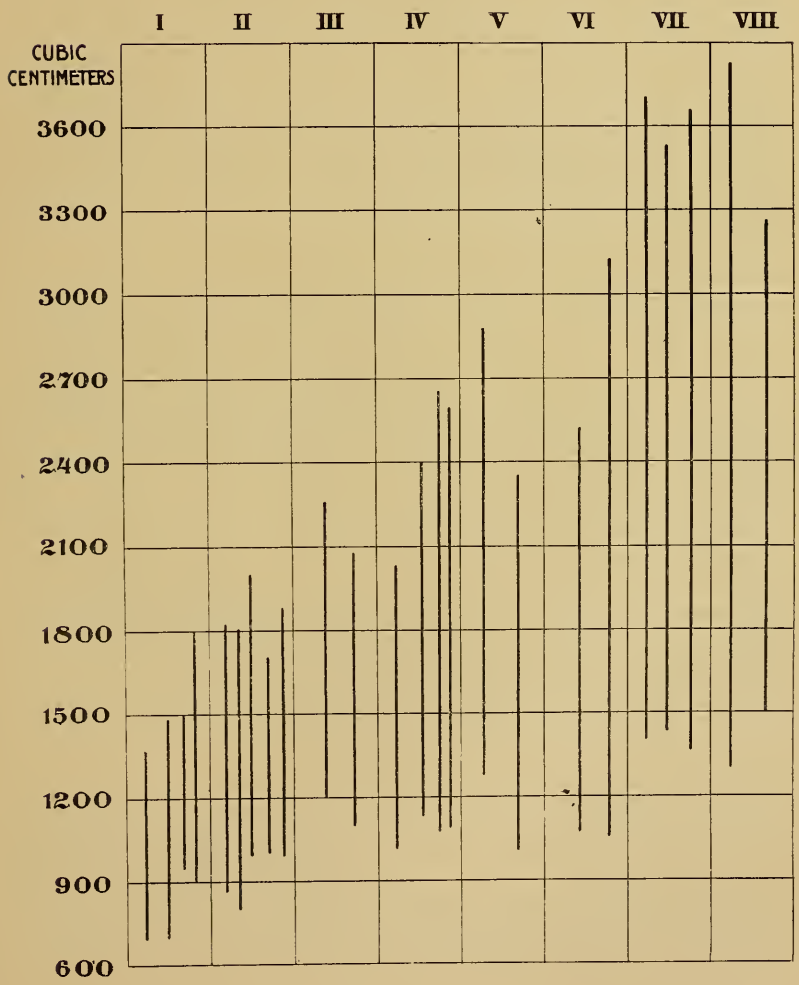


CHART XVI.

EXTREMES OF STRENGTH.

CHART XVII.

Extremes in Vital Capacity



COURSE OF POWER DURING THE DAY

The time of taking each ergographic tracing was noted on the ergogram. This furnished the data for determining the course of power throughout the school day. (See Chart XXIX.) As a check experiment eight pupils, four boys and four girls, representing about the average of the school, and selected from several different departments, were tested at intervals of about three-quarters of an hour throughout the school day. The variations in the amount of work done by each of these pupils gives the individual course of power and the average work done should have a close resemblance to the course of power for the school. (See Chart XXVIII.) For the better understanding of the problem and its solution the tracings made by one of these pupils and the chart from them are given, showing her individual course of power throughout the day. The weight used each time with this girl was three kilograms. The falling off in the amount of work done at 2:30 P. M. is probably due to some difficult task just preceding that test.

The ergograms of this pupil No. 498 are given in charts XVIII to XXVI, and the time when each was made is recorded on the chart. Table XV gives the figures belonging to these tests, and they are graphically represented in chart XXVII. The close resemblance of charts XXVII, XXVIII and XXIX to each other is quite marked and confirmatory of their accuracy. During the time that these observations were being made the children of the Alcott School were deprived of their usual morning recess, because of the obstruction of the play-ground by the work on the addition to the building. Quite probably this fact has influenced the course of the fatigue curve for the day, and it will be interesting to compare this curve with one charted from observations made at the same school later or at another having the recess. It seems fair to draw from these curves the following conclusions:

1. The extremes of endurance and fatigue in school are greater in the morning than in the afternoon.

2. A higher grade of power is found in the morning session in children attending two sessions daily.

3. While endurance is not as great, it is better sustained in the afternoon.

CHART XVIII.

9:00 80 cm. No. 498.

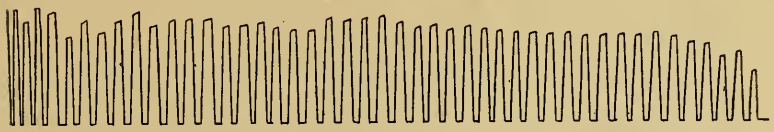


CHART XIX.

9:47 83 cm. No. 498.

CHART XX.

10:40 81 cm. No. 498.

CHART XXI.

11:30 63 cm. No. 498.

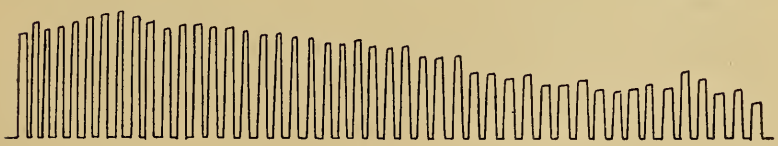


CHART XXII.

12:18 60 cm. No. 498.

CHART XXIII.

1:34 73 cm. No. 498.

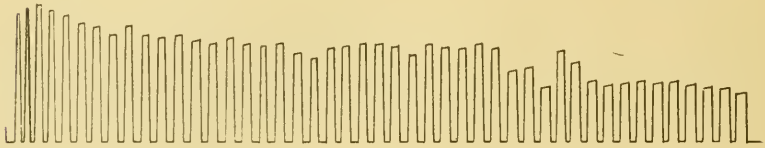


CHART XXIV.

2:20 66 cm. No. 498.

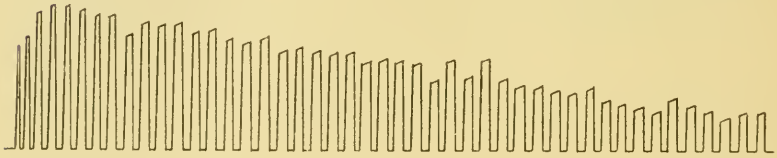


CHART XXV.

3:13 69 cm. No. 498.

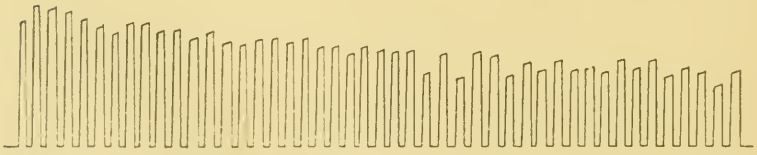


CHART XXVI.

3:55 61 cm. No. 498.

CHART XXVII.

COURSE OF POWER THROUGHOUT THE SCHOOL DAY AS DETERMINED BY THE ERGOGRAPHIC RECORDS MADE BY No. 498.

TABLE XV.

DATA—The weight, 3 kg., was lifted once in two seconds for 90 seconds.

Time of Test.....	9:00	9:47	10:40	11:30	12:18	1:34	2:20	3:13	3:55
Work Done (kg. cm.).....	240	249	243	189	180	219	198	207	183

CHART XXVIII.

COURSE OF POWER THROUGHOUT A SCHOOL DAY AS DETERMINED BY THE AVERAGE ERGOGRAPHIC RECORDS OF EIGHT PUPILS OF THE ALCOTT SCHOOL.

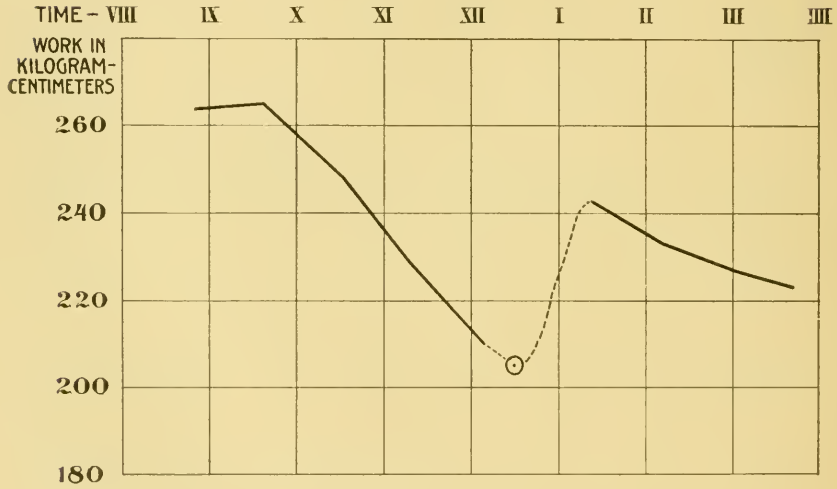


TABLE XVI.

DATA—Eight pupils (4 boys and 4 girls) were each tested nine times during the day. Each test consisted of 90 seconds' work. A weight of 3 kg. was lifted every other second.

Average Time of Test.....	8:51	9:37	10:32	11:20	12:07	1:23	2:08	3:00	3:45
Average Work Done(kg.cm).	262	263	249	229	212	243	234	228	224

CHART XXIX.

COURSE OF POWER DETERMINED FROM THE ERGOGRAPHIC RECORDS OF ELEVEN HUNDRED TWENTY-SEVEN PUPILS OF THE ALCOTT SCHOOL.

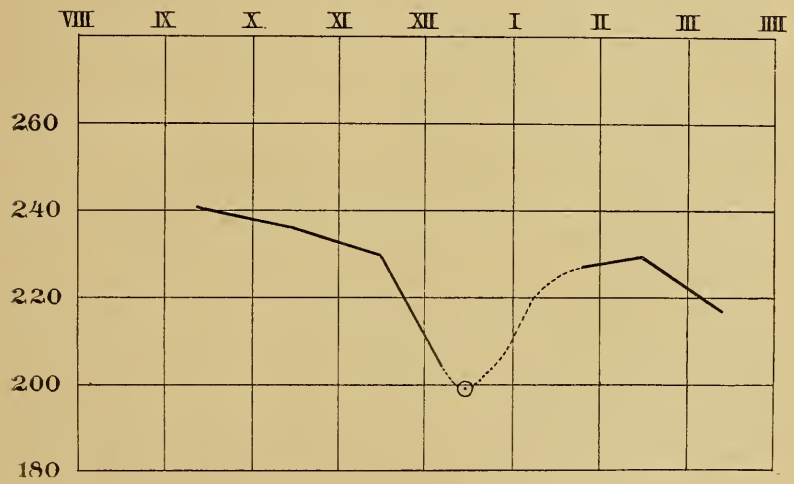


TABLE XVII.

DATA—Each test lasted 90 seconds. The weight, which was seven per cent of the pupil's weight, was lifted once in two seconds.

Average Time of Tests.....	9.35	10:32	11:28	12:11	1:51	2:31	3:21
Average Work Done (kg. cm.).....	242	237	231	204	227	229	218

AN UNGRADED ROOM.

Near the close of the school year, at the suggestion of Superintendent Andrews, the apparatus was transferred to another school and tests were made on the pupils of a special room set apart for dull and troublesome pupils. The department contained sixteen boys and four girls. The average age of the boys was eleven years, five months, ten days; that of the girls was ten years, four months and twenty-one days.

A number of developmental defects was noted among these pupils which would suggest imperfect formation of the brain. Two are marked as being microcephalic, their heads being below normal in size. Seven of the twenty are recorded as having cranial asymmetry, eight as having asymmetrical faces. Six are noted as having peculiarly formed ears, and nine as having narrow, high, or imperfectly formed palates. Five of the pupils had decided eye defects, the visual acuity being $\frac{20}{30}$ or lower, while thirteen had hearing so defective in one or both ears as to place them at a disadvantage in school work. That is, 60 per cent reached a subnormal point in hearing that only 24 per cent of the Alcott School pupils of the same age fell to.

Malnutrition was shown by marked anæmia in two of the pupils. Want of muscular tonicity was noted in seven. The nervous ergographic tracings made by most of these children, and the small amount of work done on the ergograph by them would indicate the same condition.

The averages made by these pupils was lower in every particular than the averages made by the Alcott School pupils of the same age as will appear from the following table.

TABLE XVIII.

Comparison of the averages made in the tests by the pupils of the ungraded room with the Alcott School averages:

	Net Height. Mm.	Height Sitting. Mm.	Weight. Kg.	Work on Ergograph. Kg. Cm.	Combined Strength of Hands. Kg.	Vital Capacity. c cm.
Girls of Ungraded Room	1,274	692	27.325	160	23.8	1,375
Alcott School normals for the same age	1,323	704	29.033	180	24.4	1,444
Boys of Ungraded Room	1,362	724	30.880	206	32.4	1,702
Averages for same age at Alcott School	1,378	727	31.888	261	34.6	1,763

CONCLUSIONS.

While many interesting deductions might be made from the foregoing observations, I deem it best to present only the following conservative conclusions, which I believe are fully justified by the observations:

1. In general there is a distinct relationship in children between physical condition and intellectual capacity, the latter varying directly as the former.

2. The endurance (ergographic work) of boys is greater than that of girls at all ages, and the difference seems to increase after the age of nine.

3. There are certain anthropometric indications, which warrant a careful and thorough investigation into the subject of co-education in the upper grammar grades.

4. Physical condition should be made a factor in the grading of children for school work, and especially at the entrance into the first grade.

5. The great extremes in physical condition of pupils in the upper grammar grades, make it desirable to introduce great elasticity into the work of these grades.

6. The classes in Physical Culture should be graded on a physical instead of an intellectual basis.

GENERAL REMARKS.

At this point certain questions naturally arise. Can such work as the foregoing be systematically prosecuted by the Board of Education with advantage to the schools? If so, what should be its scope?

The first question I shall answer affirmatively. The reason for this answer, as well as the answers to the second question, may be considered together. It is now very generally admitted that one function of education is sense training. To this end there has been introduced into the curriculum nature study, music, drawing, constructive work, as the manual training, etc. While it is not intended to suggest that the whole utility of these studies lies in sense training, it is that factor of them, which I am now considering. The wood-working done in manual training is not intended to fit the pupils for the carpenter trade, nor could it accomplish this. It does train the eye to measure actual and comparative distances, it does train the tactile sense, it does train the muscular sense and the joint sense. Large sums of money are spent annually to secure this training, and it is necessary to determine whether the work done trains as it is supposed to. The products of the work in a crude

way determine this question, but it can be determined with much greater nicety and accuracy by properly arranged sense tests in the hands of an observer whose psychological information gives him a full knowledge of the extent, varieties and the limitations of the senses under examination. Such examinations applied to groups of pupils will furnish reliable data from which to judge of the efficacy of the various forms of manual training, to determine the good and the bad elements in the work, and in general to fix the pedagogical value, and therefore the commercial value, of the whole work or of any of its parts.

In a similar way such examinations may be used to determine the value of all of the work done for the purposes of sense training, to discover the weak points, and to show the reason of the weakness.

HALF-DAY SESSIONS.

A problem which has vexed this Board for many years is that of half-day sessions, and its correlative problem, rented rooms for school children. Thus far it has been assumed to be desirable to provide all pupils with a full day session. Now that we realize that education is not a tangible substance to be poured into the child, doubt is thrown on this assumption. As a matter of fact it is not known at all whether it is better for the first grade pupil to attend a half day session or a whole day session. Nor is the relative value of the morning and afternoon sessions known. But both are questions of fact which can be determined by experiment and observation. But these questions could be given positive answers in two, or possibly one, year's time by a well-equipped corps of observers, working along child-study lines. Let us assume, for the sake of the argument, that it is found that half-day sessions are preferable for young children, and that afternoon sessions are as good as morning sessions. Such knowledge would not only prove of great value to the children involved but it would save the Board of Education of Chicago enough money in a single year to support the corps making the observations for half a century.

INFLUENCE OF NATIONALITY.

In certain of the Chicago schools the great bulk of the population is Italian, in others Bohemian, in others Scandinavian, in others Russian, and so on. These children bring into their school work the characteristic hereditary tendencies of the great nations from which they are descended. If the schools are to do the best for these children, and to do their share in blending these nationalties into a common American

type, the national peculiarities of these children must be known, and they can only be known by systematic, scientific study.

BACKWARD PUPILS.

The pupils of the ungraded rooms present a problem. Between the normal children and those sufficiently feeble-minded to be sent to the State institution, there is a contingent which must be handled in the schools; these are the extremely dull pupils, the bugbear of the teachers and the greatest of all drawbacks to the normal children. These children are to be gathered into ungraded rooms. Their management calls for a careful investigation of each individual child, by a trained psychologist, to determine the nature and extent of his defects, for the guidance of the teacher, who on her part must be highly trained in her profession, competent to understand thoroughly the report of the psychologist and to adapt her work to the needs of the pupil. With some of these pupils the difficulty is entirely or largely nutritional, which is outside the scope of the management of the educational authorities. In others the defect lies in the nervous system. These defects may be classified as follows:

1. Defects in the avenues to the brain and cord—i. e., defects in the senses and their tracts.
2. Defects in the brain itself.
   - (a) Structural defects.
   - (b) Nutritional defects—
     - (1) Anaemia.
     - (2) Starvation.
     - (3) Fatigue.
     - (4) Toxaemia.
3. Defects in the efferent or motor tracts.

For the first class of these defects some provision is already made in the sense—training methods used in the schools of to-day. It is necessary, however, to extend the time devoted to this training, and to apply it with the highest grade of skill to the defective pupils. As to the structural defects of the brain, medicine offers no relief. The whole hope lies in education, and fortunately it is a hope founded on good grounds. As to the nutritional defects, the fatigue element comes largely within the scope of school work, while the others are to be relegated to the physician.

The management of the motor defects is to be found in the constructive work and educational games, now so largely gaining headway in the schools.

If it is the duty of the state to educate normal children, it

is doubly its duty to educate these less favored ones, and such education cannot be conducted on guess work. It must have an accurate scientific background.

TRUANTS.

The truants present another field for child-study work. Their peculiarities should be as carefully studied as those of the children in the ungraded rooms. The parental school, soon to be established, should through such channels as is here contemplated, throw much light on the truants and the best methods of managing them. Indeed I cannot see how a truant school can be well managed until the physical peculiarities of the truants have been thoroughly studied.

LIMITATIONS OF THE WORK.

In the present series of observations it will be noted that each pupil was examined only as to seven points. The investigation was purposely restricted to these limits, in order that the largest possible number of pupils might be examined. In systematic work with such objects as have just been outlined the scope of the observations would have to be considerably extended. Nevertheless there are many problems in child study, such for instance as those relating to the emotions, which may be left to private investigators. All observations made under the Board of Education should be along lines likely to lead quickly to results which could be applied immediately in pedagogical work.

It seems to me desirable that the work thus initiated and done under the auspices of the Board of Education should be continued and made a permanent feature of the school work.

Respectfully submitted,

W. S. Christopher, M. D.,

Member Board of Education.

Report of Committee on Child-Study and Pedagogic Investigation.

Graham H. Harris, Esq., President of the Board of Education.

SIR: In the last annual report of this Board there was published an account of the child-study investigation, made under the personal direction of the chairman of this committee, during the last four months of the school year 1898–99. The Board, at its meeting of July 26, 1899, authorized the appointment of a special committee to consider the desirability of establishing in the school system of Chicago, an independent department for child-study and pedagogic investigation. The special committee so appointed, whose personnel was the same as that of the present standing committee, actuated by the results obtained in the preliminary investigation, submitted a report to the Board at its meeting of September 6, 1899, which was adopted without amendment, and from which the following extract is taken:

"There are many problems in pedagogy and child life, the solution of which can throw much light on educational procedures and materially assist in the school work; it is also desirable to have in the system a mechanism to determine, when possible, the relative value of various pedagogic methods; the varying educational needs of our large population, with its great diversity of nationalities and social peculiarities, should have accurate investigation by scientific methods; the great problems connected with dull and backward children call for earnest investigation; the type of child to be found in the parental school should also be considered. From these and other considerations we believe that there should be in the school system a department for the investigation of educational and child-study problems. The work of such a department should be limited to such of the various problems as may arise, as have a distinct pedagogic bearing and educational value; its work should be conducted in accordance with approved scientific methods, especially the methods of physiological

psychology. It should be its duty to make such investigations in child-study and pedagogy as may be suggested by the head of the department and approved by the Superintendent of Schools and the Standing Committee in charge of the department.

We recommend to the Board for its adoption the following:

1. That there be and is hereby established in the school system of Chicago, a department of child-study and pedagogic investigation, consisting of a director and such assistants as may, from time to time, be appointed to make such psychophysical and allied investigations having a pedagogic bearing, as may be suggested by the director and approved by the Superintendent of Schools and the committee in charge of the work; and also to give such instruction to the principals and the teachers in the schools as may be directed by the Superintendent of Schools and the committee.

2. Qualifications of the Director: The Director shall hold a principal's certificate and be an expert in the methods of physiological psychology.

3. Qualifications of Assistants: Assistants must hold a grammar school teacher's certificate and pass an additional examination on the methods employed in the laboratories of physiological psychology. Instead of these certificates a special certificate covering the same grounds, may be issued by the Board on examination of candidates.

4. That a standing committee of five be appointed to have charge of the department."

At the same time the two gentlemen who had made the observations in the preliminary investigation, Messrs. Smedley and Campbell, were appointed, Mr. F. W. Smedley, director of the department, and Mr. C. V. Campbell, assistant. An examination for assistants in the department was held September 16, 1899, and the special certificates required were granted to C. Victor Campbell, C. C. Krauskopf, and Daniel P. MacMillan, who were duly appointed assistants in the department. Later Miss A. Loesch joined the corps as a voluntary assistant. Miss Loesch had already done considerable laboratory work in physiological psychology at the University of Chicago and was thoroughly qualified for the work. We wish here to acknowledge the high value of Miss Loesch's services, which were freely given in the cause of science. Later Miss Loesch was appointed to do similar work in the Chicago Institute.

At the election of teachers June 13, 1900, F. W. Smedley was re-elected director of this department, and also head of the Department of Child-Study in the Normal School, with the understanding that he was to give two days each week to the Normal School and four days to this department. The time of C. Victor Campbell was also divided between this department

and the Normal School, he to devote five days per week to the child-study work of that school, and Saturdays only to the work in this department.

We wish to commend each and every member of the corps for high scientific ability, and for the careful and accurate work done. It would be unfair to omit mention of the fact that every member of the corps has put in many hours of extra work, entirely in the interests of the department, and without extra compensation.

Upon the recommendation of Dr. Frank Allport of this city, the Board, at its meeting of March 9, 1898, authorized an examination of the eyes and ears of all the school children of the city upon a plan devised by Dr. Allport, and used in numerous school systems throughout the country. Dr. Allport gave instruction to many teachers in the city upon the methods to be employed, and the work was carried out the next school year. Owing, however, to the fact that Dr. Allport had no official connection with the schools, and nobody was specifically charged with the conduct of the work, it fell into abeyance. Upon the recommendation of your committee, this work was, on April 4, 1900, put in the charge of this department, and Dr. Allport added to its staff as consulting oculist and aurist. Accordingly all the pupils were examined by their several teachers, and reports made to the director of this department. This work calls the attention of each teacher to the visual and aural defects of the children under her care, a knowledge of which facts on her part must be of great value, both to her and to the pupils. These examinations are to be repeated annually.

In the report of the preliminary investigation made last year, attention was called to the wide diversity of physical development of the pupils in individual rooms, and it was pointed out that the classes in physical culture should be arranged upon a physical, instead of an intellectual basis, as is now done. Your committee recommends that efforts to secure such an arrangement of the classes in physical culture, be made in the near future.

The preliminary investigation of last year established clearly that in each room there was a great range of physical capacity and endurance among the different pupils; it also established the fact that this differentiation constantly increased from the first grade to the eighth. It was also claimed that these facts called for increasing elasticity in the school work, and that such elasticity was especially called for in the upper grammar grades. The appended report of Director Smedley further supports this contention with some new and important facts. The desirability and necessity of such elasticity has long been recognized by progressive educators, and any adaptation

of it must be of a purely pedagogical character. Your committee, therefore, recommends that the Superintendent of Schools be directed to investigate the matter and report such measures securing elasticity of work as may be found feasible.

The main work of the department throughout the year has been a continuation of the line of observations started in the preliminary investigation, with, however, a somewhat extended scope. By this means tables of norms of great value have been produced, and many interesting and valuable relationships shown. In all of the schools in which the child-study corps was engaged in making observations, instruction to the teachers was also given in child-study. This part of the work might be advantageously extended, and could be if the corps should be increased by the addition of one or two more teachers. Such increase would in other ways materially strengthen the department and increase its usefulness.

At the John Worthy School, attached to the Bridewell, measurements were made of 284 boys. By comparing the results of these measurements with the norms obtained by measuring normal children, it is found that the boys in the John Worthy School are inferior in all the physical measurements taken, and this inferiority seems to increase with age. While the number examined at the John Worthy School is not sufficient to warrant far reaching conclusions, it is to be noted that the general result of the examination fits with the general observations of those familiar with the boys at the school. As the population of the school is constantly changing, it will be possible to add rapidly to the number of boys examined, and thus obtain results which are reliable. If further investigation confirms the observation of physical inferiority of the boys who are sent to the John Worthy School, it will have far reaching results. Such physical inferiority means, broadly, malnutrition. While this is not the place to discuss the causes of malnutrition, social, hereditary, dietetic, infectious, etc., it seems right, however, to remind the Board that the Parental School now in course of construction will be called upon to receive many of the boys who are now sent to the Bridewell in default of a more suitable place. In view, therefore, of the results of the measurements of the boys of the John Worthy School, your committee recommends that in the management of the Parental School, the physical welfare of the inmates be made a matter of fundamental care, and that to this end great attention be paid to the dietary of the institution, that it be wholesome, nutritious, and sufficient; that provision be made for physical exercise, sufficient and not excessive in amount, and of a character adapted to the needs of the inmates; that ample and varied bathing accommodations be provided; that clothing adapted to the weather and the occupations of the school be

supplied; and that the sleeping quarters be made thoroughly comfortable and hygienic.

At its meeting of April 4, 1900, the Board authorized the establishment of a psycho-physical laboratory in the department and appropriated $250.00 for the purchase of apparatus. As soon as the apparatus could be gotten together the laboratory was opened in a partially unused room connected with the offices of the Board. The laboratory has been opened on Saturdays only, as upon other days the members of the corps have been engaged in their routine work in the schools. To the laboratory backward or difficult pupils may be brought from any school in the system, by the principals, upon previous arrangement with the Director of Child-Study. Each pupil is subjected to a careful and thorough psycho-physical examination and such advice given, as the results obtained suggest to the trained psychologists in charge. Miss Luella Heinroth, the principal of the Schiller School, brought to the laboratory some fifteen backward pupils, and after obtaining the results of the thorough investigation of each of them, very wisely asked that an ungraded room be established in her school for their benefit. The necessary action of the Board was obtained through the recommendation ot the School Management Committee, and the room will be in operation next session. In this connection your committee desires to call attention to the principles involved in the establishment of this particular ungraded room and to recommend that they be followed hereafter in establishing similar rooms. The principles referred to are the following:

1. Limitation of the maximum number of pupils in the room to twenty.

2. Requiring all pupils who are to be assigned to the room, to be first examined in the Child-Study Laboratory.

3. Requiring the course of study used in such a room to be specially determined for such room, by the Superintendent of Schools, the Assistant Superintendent of the District, and the Director of Child-Study.

4. Requiring that the teacher assigned to such room, shall be experienced in actual teaching, and sufficiently versed in psychology and human anatomy, physiology and pathology to thoroughly understand and appreciate the results of the psycho-physical examination made in the laboratory, so that proper advantage may be taken of the results for the highest benefit of the pupils.

There will always be found in the school system, a class of pupils who are so backward that they gain little or nothing from the ordinary course of instruction and whose presence in the general class room is distinctly detrimental to the remaining pupils, but who are yet not so deficient mentally as to justify

sending them to the State Institution for the Feeble Minded. Such pupils must be cared for in the common schools, but justice to them, and to the more normal pupils demands that the two classes be separated and the backward pupils placed in the so-called "ungraded rooms."

A conservative estimate of the number of such backward pupils in the Chicago schools would indicate that at least one ungraded room should be established in every large school, say possibly two hundred such rooms throughout the city. These backward pupils present a mixture of pedagogical, psychological, and medical problems of the highest interest and the greatest complexity, and require, for their proper management, teachers of the highest skill and broadest knowledge and training. It will naturally be difficult to find teachers possessing the necessary qualifications for such work, and your committee therefore recommends that the establishment of ungraded rooms be proceeded with slowly and that steps be taken to establish in the Normal School courses of instruction, preferably post-graduate, for the training of teachers for ungraded rooms.

The analogy between the professions of pedagogy and medicine has often been pointed out. It is strikingly close. In its professional development, pedagogy is now at the stage where medicine was a century ago, that is to say, rigid scientific research, and the exact methods of the laboratory are breaking in upon the old time empiricism. Much can be learned to the benefit of pedagogy from the history of the development of the older profession. In medicine the scientific methods met with considerable opposition, but finally advanced to commanding positions, influencing radically the methods of professional thought and adding extensively to the stores of knowledge, and all to the great advantage of the profession, and of those who are the objects of its ministrations. The scientific methods are approaching pedagogy through the gateways of psychology and child-study, and they should be welcomed and encouraged by the profession, for not only is professional development of the highest utility to pupils, but it is also the greatest safeguard of the teachers.

Critical scientific pedagogic investigation must necessarily increase the sum total of accurate pedagogic knowledge, and to this end an extension of pedagogic research is much to be hoped for. Particularly is it desirable that research departments similar to our own, be established in the school systems of other large cities, for in this way not only is the bulk of work done very rapidly increased, but the benefit of many minds at work at the same time on different types of problems, is obtained. Private research is doing, and has done much for psychology and child-study, but it lacks the force and continuity of publicly supported research. In the medical sciences, research has

always lacked public support in English-speaking countries, while it has always received such support in the countries of continental Europe. The result has been that such of the new facts in these sciences as are of laboratory origin, have mostly come from the continent of Europe, and in this way great honor and advantage have accrued to those countries and to the professional workers there, while corresponding disadvantages have been the fate of biological workers in English-speaking countries. Educational interests, on the other hand, are remarkably well supported by public funds in this country. The schools are everywhere looked upon as the bulwark of the nation. The States generally have established minimum limits for the education of their children, and have provided means for the education of all, far beyond these limits. The State practically monopolizes primary and secondary instruction. It seems only right, therefore, that the advancement of pedagogic knowledge should be a matter of public concern. So far as we are aware, your Board is the first public Board of Education, to formally recognize these facts, and to establish in the school system under its charge a special department for pedagogic research. There is a Pedagogic Laboratory at Antwerp, Belgium, but whether it constitutes an exception to this statement, we are unable to say.

The child-study investigation in the Chicago schools has met with much favorable criticism both in this country and in Europe.

During the coming school year it is intended to put the department at work upon some problem of immediate pedagogic interest, the particular problem to be determined by the Superintendent of Schools.

Appended hereto is the report of Director Smedley, giving in detail the results of the scientific work of the department during the past year. This document is replete with facts of great value to the school system, and more than justifies the action of the Board in establishing the department. Special attention is called to that portion of the report relating to the pubescent period of life. The recommendations contained in Mr. Smedley's report meet with our full approbation.

In conclusion we give the following brief outline of the objects and functions of the Department of Child-Study and Pedagogic Investigation:

I. Research Work—

a. Collecting anthropometric and psycho-physical data for the purpose of establishing norms, and for determining such relationships as may be of service in pedagogy.

b. Applying accurate scientific methods to specific pedagogic problems, particulary methods of teaching,

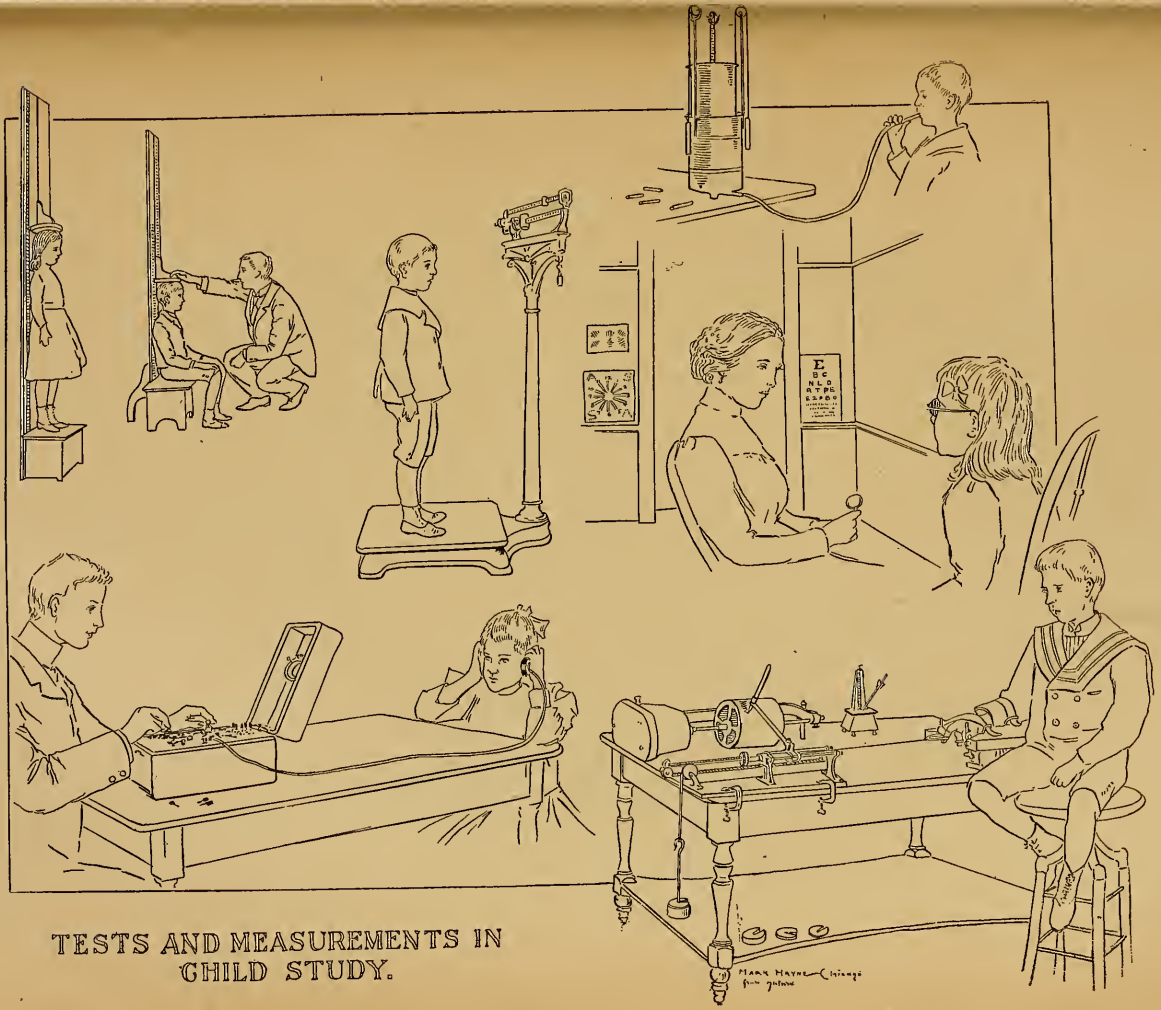
and determination of the pedagogic value of various studies.

II. Examination of Individual Pupils with a view to advising as to their pedagogic management.

III. Instruction to Teachers in child-study and psychology.

Respectfully submitted,

W. S. Christopher,
F. J. Loesch,
C. Meier,
Clayton Mark,
Joseph Stolz,
Committee on Child-Study and Pedagogic Investigation.



TESTS AND MEASUREMENTS IN CHILD STUDY.

FIG. 1

Report of Director Fred W. Smedley.

To the Committee on Child-Study and Pedagogic Investigation, W. S. Christopher, Chairman:

GENTLEMEN—As suggested by you, the work of the Department of Child-Study and Pedagogic Investigation for the past year has consisted mainly of a continuation of the tests inaugurated by Dr. W. S. Christopher in March, 1899, and reported by him in the Annual Report of the Board of Education for last year. It seems but natural that the starting point for a systematic pedagogical study of Chicago school children should be an attempt to determine the laws of their growth and the relationship which may exist between physical growth and mental development.

As the methods and apparatus were fully described in Dr. Christopher's report, they will receive only the briefest consideration here. The results of the tests on each individual pupil were recorded on a card, the following copy of which will serve to show the scope of the data collected.

No.....

Name.....

Grade.....No. of weeks in this Grade.....

School.....Room No.....

Teacher.....

Date of Birth—Year.....Month.....Day.....

Place of birth.....

Place of birth of father.....

Place of birth of mother.....

School Standing.....	.....	.....
Attention.....	.....	.....
Memory.....	.....	.....
Judgment.....	.....	.....
Best work is in.....	.....	.....
Poorest work is in.....	.....	.....
Deportment.....	.....	.....
Date.....	.....	.....
Age.....	.....	.....
Height with shoes.....	.....	.....
Height of heel.....	.....	.....
Net height.....	.....	.....
Height sitting.....	.....	.....
Weight with clothes.....	.....	.....
Weight of clothing, est.....	.....	.....
Net weight, est.....	.....	.....
Ergograph—Hour.....	.....	.....
Weight used.....	.....	.....
Centimeters travelled.....	.....	.....
Work—Centm. Kg.....	.....	.....
Duration of work.....	.....	.....
Strength of Grip, R. H.....	.....	.....
" " L. H.....	.....	.....
Vital Capacity.....	.....	.....
Audiometer, R.....	.....	.....
" L.....	.....	.....
Visual Acuity, R.....	.....	.....
" " L.....	.....	.....
Motor Ability.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

The use of cards with one color for the boys and another for the girls allows the quick compilation of the data in any manner desired by changing the grouping of the cards.

THE ESTABLISHMENT OF NORMS.

Up to date, tests have been made on the pupils of the Alcott, Kozminski, Andersen, and Tennyson elementary schools, the eighth grade and the kindergarten in the Hoyne School, the kindergartens of the Burr, Kinzie and Sheldon schools, and also the pupils of the Englewood and Lake View High schools, in all, 6,259 pupils, 2,788 boys and 3,471 girls. The pupils of these schools are largely of American parentage and are the children of parents in comfortable circumstances, so that they are uniformly well fed and clothed. Therefore, it is believed that they may be taken to represent normal Chicago children, living under good conditions. From these tests and measurements, tables of norms have been compiled. As we were obliged to compile the data several times, we have been able to watch the changes which added numbers have produced. These changes of the norms from the addition of the last set of cards representing the measurements of about fifty pupils of each year of age, between the ages of six and sixteen, have been so slight that it is believed that these norms are fairly representative of the class of pupils tested for these years. And probably large additions to these figures, if the data were taken from the same class of pupils, would but slightly change the averages thus established. The norms for the upper years, sixteen to twenty-one, and also for the kindergarten ages, four to six, on account of the paucity of numbers can hardly be considered so completely established. In these compilations, averages have been used rather than medians, although the difference between averages and medians proved insignificant. The mathematical computations were made by means of a comptograph, so "machine accuracy" in the results has been obtained. That these results may be quickly and clearly understood, charts have been made of the growth and development along the lines in which tests and measurements have been made. It is not assumed that a single child grows at exactly the same regular movement upward as is shown by the tables and charts, yet it is believed that ordinarily children do not differ widely from this rate, and the average of a small number of the same class of boys and girls taken from year to year would give us figures almost identical with the results of these compilations. So these tables fairly show laws of growth and physical development.

There is a prevalent belief, growing out of the evolutionary doctrine of the survival of the fittest, that the average

represents the ideal type. As these measurements must include many imperfect specimens, children who through disease, malnutrition and other insalutary conditions have failed to attain the growth and development that they otherwise would have reached, in all probability the evolutionary ideal type will be found somewhat above the average in each measurement. These averages are representative of the class of children measured, and are highly important as a basis of comparison. It may be added that comparison of these measurements with those taken in other cities shows the superiority of this class of Chicago school children in both size, and physical development.

TABLE I. NORMS—BY AVERAGES.

BOYS.

AGES.	Number Examined.	Standing Height. Millimeters.	Sitting Height. Millimeters.	Weight with Clothing. Kilograms.	Work on Ergograph. Kilogram-Centimeters.	Grip of Right Hand. Kilograms.	Grip of Left Hand. Kilograms.	Vital Capacity. Cubic Centimeters.
4-6-13	41	1012	583	16.984	.....	5.50	5.08	736
5-7-14	70	1076	612	18.402	82.1	7.80	7.12	930
6-6- 6	227	1133	636	20.716	105.4	10.	9.32	1098
7-5-27	230	1183	658	22.535	139.2	11.50	10.91	1240
8-5-21	255	1234	677	25.022	168.2	13.27	12.40	1388
9-6- 4	228	1289	699	27.616	205.6	15.39	14.54	1549
10-6- 2	254	1330	713	29.837	235.	17.68	16.66	1659
11-5-17	228	1370	729	32.519	267.7	19.94	18.72	1799
12-5-23	256	1418	747	35.626	297.8	22.40	20.58	1956
13-5-14	230	1488	777	40.276	357.2	26.26	24.23	2246
14-5-20	250	1546	806	44.786	423.8	30.29	27.94	2527
15-5-25	205	1613	837	50.994	513.5	36.30	33.65	2858
16-5-15	146	1665	871	55.219	584.7	42.12	38.82	3363
17-5-18	92	1690	891	59.243	651.4	46.99	42.74	3570
18-4-27	40	1731	914	62.858	700.9	51.04	46.75	3701
19-4-18	23	1721	911	64.326	733.4	54.11	49.33	3872
20-5-12	8	1741	923	68.294	737.8	56.	48.50	3788
21-3-14	5	1704	911	63.955	727.4	52.	47.40	3770

GIRLS.

4-7-10	36	1008	585	16.342	.....	5.64	5.17	754
5-7- 2	81	1065	602	17.979	62.2	7.23	6 58	855
6-6- 8	204	1126	629	19.968	98.3	9.15	8.52	1008
7-6-15	236	1185	653	22.115	109.5	10.71	10.06	1121
8-6- 1	232	1228	674	23.995	142.5	11.67	10.96	1215
9-6- 7	221	1278	692	26.540	171.4	13.89	13.01	1360
10-5-15	240	1322	708	28.969	190.1	15.37	14.40	1456
11-5-16	223	1381	735	32.132	221.7	17.57	16.50	1587
12-5-15	247	1441	762	36.326	245.9	20.09	18.88	1729
13-6-13	255	1513	797	41.629	294.5	23.60	21.51	1924
14-6-13	301	1564	826	47.181	344 2	26.19	24.11	2117
15-6- 1	379	1574	840	49.345	356.5	27.92	25.81	2225
16-6- 0	354	1592	851	51.964	397.3	29.50	27.31	2306
17-5-10	251	1597	853	52.761	370.1	29.62	27.11	2304
18-4-25	137	1595	857	53.015	381.6	29.84	27.76	2351
19-5- 4	48	1599	855	54.600	416.8	31.21	28.85	2441
20 4-12	22	1588	848	54.033	363.3	29 96	27.45	2348
21-5- 8	4	1583	862	54.763	506.9	32.19	29.31	2250

BIRTHDAY NORMS.

In compiling these norms the age at the last birthday was used. It was assumed that the actual average age for any year would be that year and about six months. When the average ages were made out it was found, as will appear on the table, that in some years the ages averaged above the half year and in some below. In order to ascertain the norms for the exact years and half years, the daily and monthly increments were calculated. The increment between any two average ages divided by the exact number of days between those ages gives the average daily increment, and this multiplied by thirty and five-twelfths gives the average monthly increment. On this basis, a table of norms computed to integral years and half years for the ages from six to eighteen and a half, has been calculated and is given in both the French and the English systems of measurements, together with a table of the monthly increments. In these tables, where the averages of the girls are greater than the averages of the boys for corresponding ages, the measurements have been printed in heavy faced type.

These norms, computed to the integral years, are, for the sake of convenience, termed "Birthday Norms."

TABLE II. BIRTHDAY NORMS.

BOYS.

AGE.	Standing Height. Millimeters.	Sitting Height. Millimeters.	Weight With Clothing. Kilograms.	Work on Ergograph. Kilogram-Centimeters.	Grip of Right Hand. Kilograms.	Grip of Left Hand. Kilograms.	Vital Capacity. Cubic Centimeters.
6-0	1106.9	624.0	19.738	92.86	9.21	8.48	1023
6-6	1132.5	635.4	20.675	104.79	9.97	9.29	1096
7-0	1158.2	646.7	21.613	122.12	10.74	10.11	1168
7-6	1183.9	657.8	22.550	139.45	11.51	10.92	1241
8-0	1209.3	667.5	23.817	154.17	12.41	11.67	1316
8-6	1234.8	677.2	25.083	168.89	13 31	12.43	1392
9-0	1261.4	687.9	26.336	187.07	14.34	13.47	1469
9-6	1288.0	698.5	27.589	205.24	15.37	14.51	1547
10-0	1309.1	705.6	28.707	220.03	16.52	15.59	1603
10-6	1330.3	712.6	29.825	234.82	17.67	16.66	1659
11-0	1351.1	721.0	31.223	251.86	18 85	17.72	1732
11-6	1371.9	729.3	32.619	268.89	20.03	18.80	1806
12-0	1395.4	738.0	34.151	283.83	21.24	19.71	1883
12-6	1418.9	747.0	35 684	298.75	22.45	20.62	1960
13-0	1455.4	762.4	38.084	329 21	24.44	22 51	2108
13-6	1490.9	777.9	40.485	359.69	26.43	24.40	2257
14-0	1519.2	792.1	42.696	392.62	28.42	26.22	2395
14-6	1547.4	806.4	44.908	425.55	30.40	28.04	2533
15-0	1580.7	821.8	47.993	470.13	33.39	30.88	2697
15-6	1614 1	836.8	51.078	514.72	36.38	33.73	2860
16-0	1640.3	854.3	53.238	551.22	39.37	36.39	3120
16-6	1666.5	871.7	55.398	587.73	42.35	39.04	3380
17-0	1678.5	881.6	57.384	620.64	44.74	40.96	3483
17-6	1690.4	891.4	59.371	653.53	47.14	42.87	3586
18-0	1712.3	903.0	61.288	679.73	49.28	45.01	3655
18-6	1734.1	914.6	63.204	705.82	51.43	47.16	3725

GIRLS.

6-0	1096.6	617.2	18.870	87.79	8.36	7.74	950
6-6	1125.1	629.0	19.922	97.90	9.12	8.49	1006
7-0	1153.7	640.7	20.974	108.00	9.88	9.24	1061
7-6	1182.2	652.5	22.026	118.10	10.65	9.99	1117
8-0	1204.9	663.4	23.010	130.24	11.16	10.48	1165
8-6	1227 5	674.3	23 994	142 38	11.67	10.96	1214
9-0	1252.4	683.2	25.257	156.73	12.77	11.97	1286
9-6	1277.4	692.1	26.520	171.08	13.88	12.99	1358
10-0	1300.7	700.5	27.795	180.98	14.65	13.72	1409
10-6	1324.1	708.9	29.072	190.88	15.43	14 46	1460
11-0	**1353.5**	**722.3**	30.662	206.90	16.54	15.52	1526
11-6	**1383.0**	**735.8**	32.250	222.92	17.65	16.58	1592
12-0	**1413.1**	**749.3**	**34.373**	234.92	18.92	17.78	1664
12-6	**1443.2**	**762 9**	**36.495**	246.92	20.19	18.97	1736
13-0	**1476.8**	**779.1**	**38.974**	269.89	21.84	20.39	1827
13 6	**1510.4**	**795.4**	**41.454**	292.86	23.49	21.80	1918
14-0	**1536.4**	**809.9**	**44 219**	318.12	24.79	22.92	2014
14-6	**1562.4**	**824.3**	**46.983**	343 38	26.10	24.03	2111
15-0	1568.3	**832.1**	**48.161**	349.83	27.00	24.92	2168
15-6	1574.2	839.9	49.339	356.29	27.91	25.80	2225
16-0	1583.0	845.4	50.652	361.10	28.70	26.56	2286
16-6	1591.8	850.9	51.964	365.92	29.50	27.31	2306
17-0	1592.6	852.0	52.386	370.74	29.56	27.43	2319
17-6	1593.4	853.0	52.807	375.55	29.63	27.55	2331
18-0	1594.2	855.1	52 923	380.37	29.75	27.66	2343
18-6	1595.0	857.2	53.039	385.19	29.87	27.77	2355

Table III.

AVERAGE MONTHLY INCREMENT OF BIRTHDAY NORMS.

BOYS.

AGE.	Standing Height. Millimeters.	Sitting Height. Millimeters.	Weight with Clothing. Kilograms.	Work on Ergograph Kilogram-Centimeters.	Grip of Right Hand. Kilograms.	Grip of Left Hand. Kilograms.	Vital Capacity. Cubic Centimeters.
6½ to 7½	4.3	1.8	.156	2.89	.13	.14	12
7½ to 8½	4 2	1.6	.211	2.45	.15	.13	13
8½ to 9½	4.4	1.7	.209	3.03	.17	.17	13
9½ to 10½	3.5	1.2	.187	2.46	.19	.18	9
10½ to 11½	3.5	1.4	.233	2.84	.19	.18	12
11½ to 12½	3 9	1.5	.256	2.50	.20	.15	13
12½ to 13½	6 1	2.6	.400	5.08	.33	.32	25
13½ to 14½	4.7	2.4	.368	5.49	.33	.30	23
14½ to 15½	5.6	2.5	.514	7.43	.50	.48	27
15½ to 16½	4.4	2.9	.360	6.08	.50	.44	43
16½ to 17½	2.6	1.6	.331	4.49	.40	.32	17
17½ to 18½	3.7	1.9	.320	4.34	.36	.36	11

GIRLS.

6½ to 7½	4.7	2.0	.175	1.68	.12	.12	9
7½ to 8½	3 8	1.8	.164	2.02	.09	.08	8
8½ to 9½	4 2	1.5	.211	2.39	.18	.17	12
9½ to 10½	3.9	1.4	.213	1.65	.13	.12	8
10½ to 11½	4 9	2.3	.265	2.67	.18	.18	11
11½ to 12½	5.0	2.2	.353	2.00	.21	.20	12
12½ to 13½	5 6	2.7	.413	3.83	.28	.28	16
13½ to 14½	4.3	2.4	.461	4.21	.22	.19	16
14½ to 15½	1.0	1.3	.196	1.08	.15	.15	10
15½ to 16½	1.5	.9	.219	.80	.13	.12	7
16½ to 17½	.1	.2	.070	.80	.01	.02	2
17½ to 18½	.1	.3	.019	.80	.02	.02	2

Table IV.

TRANSLATION OF BIRTHDAY NORMS INTO THE ENGLISH SYSTEM OF WEIGHTS AND MEASURES.

BOYS.

Age.	Height. Inches.	Height Sitting. nches.	Weight. Pounds.	Ergograph. Foot-Pounds.	Right Hand Grip. Pounds.	Left Hand Grip. Pounds.	Vital Cap'ity. Cubic Inches.
6-0	43.58	24.57	43.52	6.33	20 30	18.70	62.403
6-6	44.59	25.02	45.59	7.58	21.98	20.48	66.856
7-0	45.60	25.46	47.66	8.84	23.68	22.29	71.248
7-6	46.61	25.90	49.72	10.09	25.38	24.08	75.701
8-0	47.61	26.28	52.53	11.15	27.36	25.73	80.276
8-6	48.61	26.66	55.31	12.22	29.35	27.41	84.912
9-0	49.66	27.09	58.07	13.53	31.62	29.70	89.609
9-6	50.71	27.50	60.83	14.85	33.89	31 99	94.367
10-0	51.54	27.79	63.30	15.92	36.43	34.38	97.783
10-6	52.38	28.06	65.76	16.99	38.96	36.73	101.199
11-0	53.20	28.39	68.85	18.22	41.56	39.07	105.652
11-6	54.02	28.72	71.92	19.45	44.17	41.45	110.166
12-0	54.94	29.06	75.30	20.32	46.83	43.46	114.863
12-6	55.87	29.40	78.68	21.61	49.51	45.46	119.560
13-0	57.30	30.02	83.98	23.82	53.89	49.63	128.588
13-6	58.70	30.63	89.27	26.02	58.28	53.80	137.677
14-0	59.82	31.19	94.14	28.41	62.67	57.81	146.095
14-6	60.93	31.75	99.02	30.79	67.03	61.82	154.513
15-0	62.24	32.36	105.82	34.01	73.62	68.09	164.617
15-6	63.55	32.95	112.63	37.24	80.22	74.37	174.460
16-0	64.59	33.64	117.39	39.89	86.81	80.24	190.320
16-6	65.62	34.32	122.15	42.52	93.38	84.08	206.180
17-0	66.10	34.71	126.53	44.90	98.65	90.31	212.463
17-6	66.56	35.10	130.91	47.28	103.94	94.52	218.746
18-0	67.42	35.55	135.14	49.18	108.67	99.24	222.955
18-6	68.28	36.01	139.36	51.06	113.40	103.98	227.225

GIRLS.

6-0	43.179	24.301	41.608	6.351	18.43	17.07	57.950
6-6	44.299	24.765	43.928	7.083	20.11	18.72	61.366
7-0	45.425	25.226	46.248	7.813	21.79	20.37	64.721
7-6	46.541	25.691	48.568	8.544	23.48	22.03	68.137
8-0	47.441	26.120	50.737	9.422	24.61	23.11	70.165
8-6	48.332	26.550	52.907	10.300	25.73	24.17	74.054
9-0	49.311	26 900	55.691	11.338	28.16	26.39	78.446
9-6	50.296	27.250	58.476	12.377	30 61	28.63	82.838
10-0	51.214	27.581	61.288	13.093	32.30	30.25	85.949
10-6	52.235	27.912	64.103	13.809	34.02	31.88	89.060
11-0	**53.292**	**28.440**	67.610	14.969	36.47	34.22	93.086
11-6	**54.454**	**28.971**	71.116	16.127	38.92	35.56	97.112
12-0	**55 640**	**29.502**	**75 792**	16.996	41.72	39.20	101.504
12-6	**56.824**	**30.038**	**80.471**	17.864	44.52	41.83	105.896
13-0	**58.147**	**30.676**	**85.938**	19.525	48.16	44.96	111.447
13-6	**59.468**	**31.318**	**91.406**	21.187	51.80	48.08	116.998
14-0	**60.494**	**31.889**	**97.503**	23.013	54.66	50.54	122.854
14-6	**61.518**	**32.455**	**103.598**	24.837	57.55	52.99	128.778
15-0	61.750	**32.763**	**106.195**	25.308	59.54	54.95	132.241
15-6	61.992	33.070	108.792	25.778	61.54	56.89	135.725
16-0	62.328	33.286	111.688	26.125	63.28	58.56	138.226
16-6	62.675	33.503	114.580	26.474	65.05	60.22	140.666
17-0	62.707	33.546	115.514	26.823	65.18	60.48	141.759
17-6	62.738	33.586	116.439	27.171	65.33	60.75	142.191
18-0	62.770	33.668	116.695	27.520	65.60	60.99	142.923
18-6	62.801	33.751	116.951	27.866	65.86	61.23	143.655

CHART I.

Growth in Height and Height Sitting.

Based on Data in Table I.

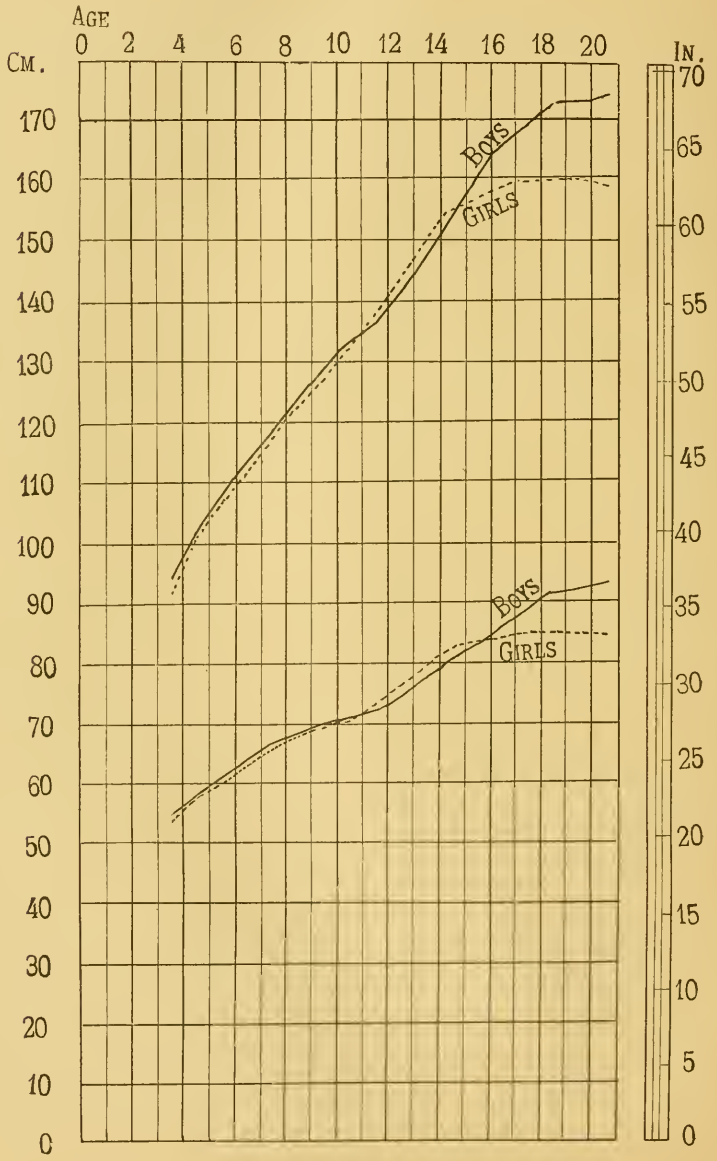


CHART II.

Growth in Weight and Development of Strength.

Based on Data in Table I.

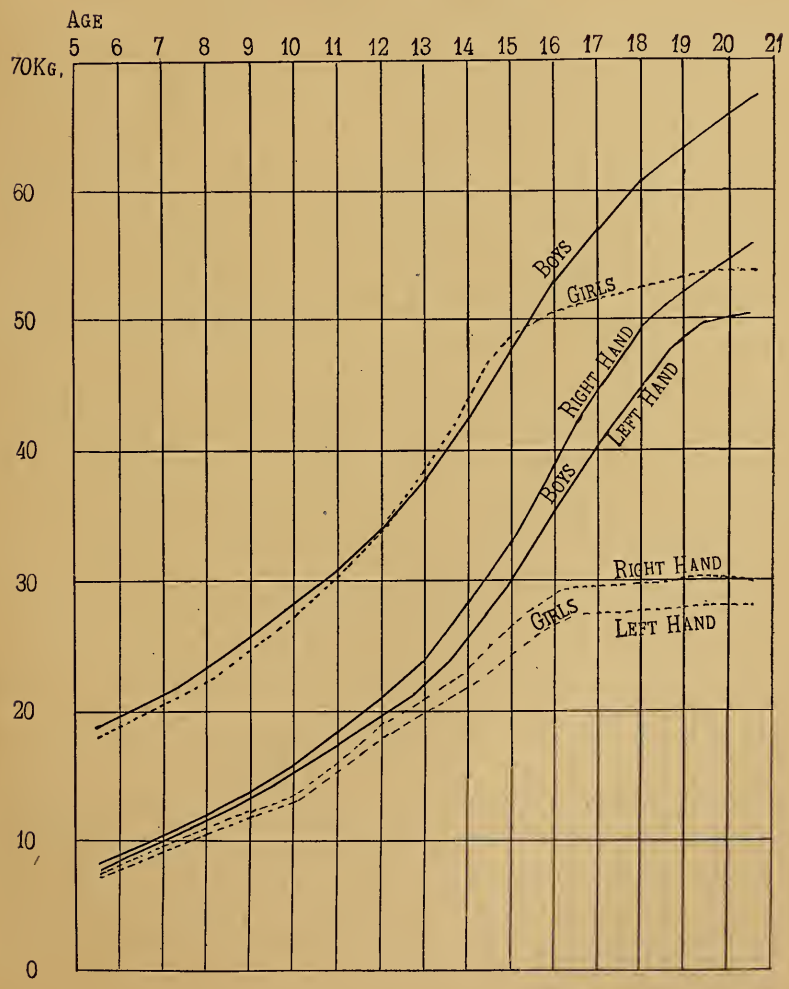


CHART III.

Development of Vital Capacity.

Based on Data in Table I.

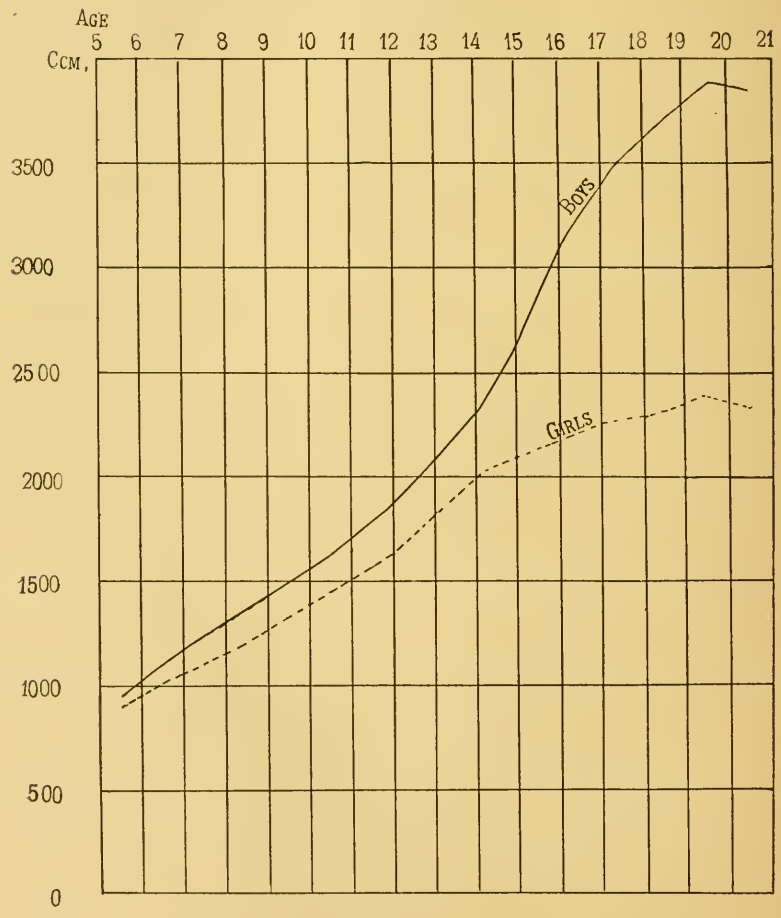
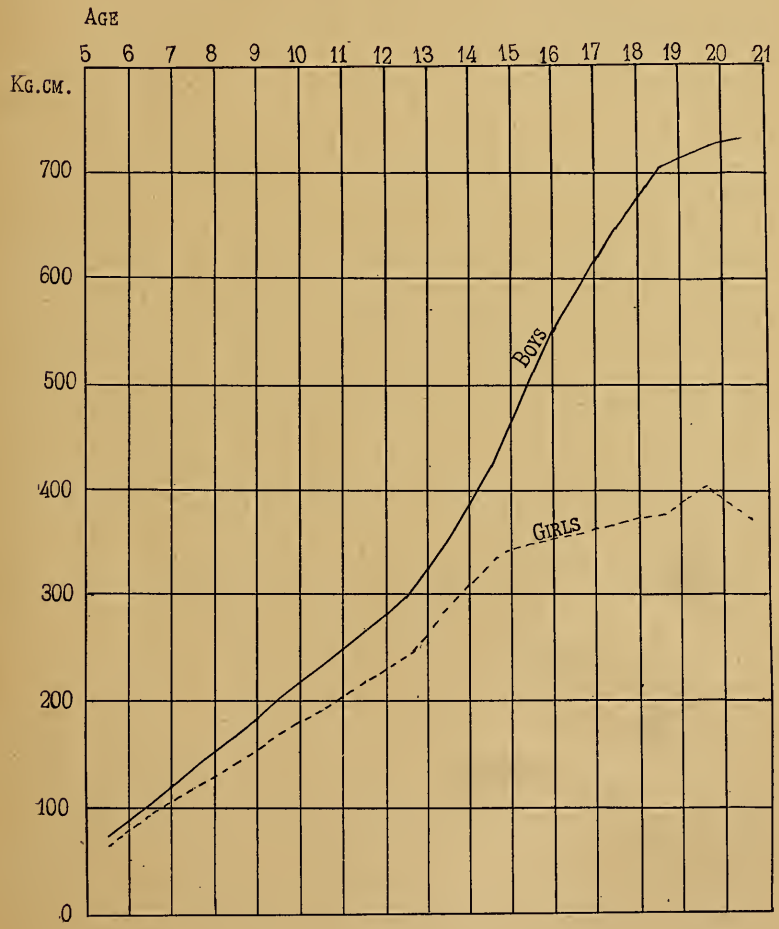


CHART IV.

Development of Endurance as Determined by the Power to Do Work on the Ergograph.

Based on Data in Table I.



GROWTH IN HEIGHT AND HEIGHT SITTING.

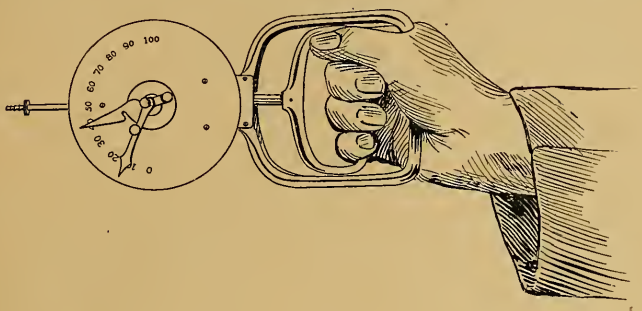
Height was measured by means of an adaptation of the Bertillon stadiometer. The heels of the shoes were calipered and the height of the shoe heels taken from the gross height gave the net height. This, upon trial, proved almost identical with the height when taken without shoes. The results of the compilation of height standing and height sitting will be found in Table I. This growth in stature has been graphically represented in Chart I. The scale at the right of the chart will assist in making a rough translation from the French to the English system of measurement. It will be noted that the average girl is shorter than the average boy when they enter the kindergarten, but just before reaching eleven years of age, owing to a slackening of the boy's rate of growth and an acceleration of the girl's, the average girl becomes taller than the average boy and remains taller till they reach the age of fifteen years. At this period the girls seem to be exhausted in the race, and the boys surpass the girls in height and continue to increase the difference in stature for a number of years.

As in height standing so in height sitting, when the pupils enter the kindergarten the average boy is slightly taller when seated than the average girl, but just before attaining the age of eleven years the average girl surpasses the average boy in height sitting. This again seems due as much to a retardation in the boy's rate of growth as to an acceleration in the girl's rate of growth. The average girl continues taller when seated than the average boy till nearly sixteen years, or almost a year longer than her height standing exceeds the height standing of the average boy. This shows that the more rapid growth of the boy at this age is chiefly in the lower extremities rather than in the trunk. This great change in the proportions of the body will be readily seen if one looks at the chart as a whole, the distance from the base line to the curve of height sitting representing the length of the trunk, and the distance from the curve of height sitting to the curve of height standing representing the length of the lower extremities.

GROWTH IN WEIGHT.

As we found in stature so we find in weight that the average boy exceeds the average girl during the early years of school life. During the three years from twelve to fifteen the average girl is heavier than the average boy. Soon after fifteen is reached the boy surpasses the girl in weight and he continues to increase in weight more rapidly than she does for a number of years. It will be noted that the average girl surpasses the average boy in weight at about a year later than her stature ex-

ceeds his. The curves and tables of weight and height show that the girls continue to increase in weight for a longer period than they increase in height.



THE DEVELOPMENT OF STRENGTH.

Strength of grip was tested at first by an ordinary two-spring dynamometer, but an attempt to test the young children with this instrument proved that it was entirely unsuited to the size of their hands. Those with the smallest hands were forced to use a different set of phalanges from those which the adult would use on the same instrument. Again, it was found that the adult could make his best record only when the instrument was suited to the size of his hand. For this reason we were forced to devise a new dynamometer which could be adjusted to the size of the hand. This new adjustable grip dynamometer is represented in Fig. 2. It is set by changing the distance between the bars of the inner and outer stirrups. This is accomplished by whirling the inner stirrup, a screw thread passing through a nut below the dial, causing the protrusion or withdrawal of the stem of the stirrup. A distance between the bars corresponding to about one-half of the distance from the place where the thumb joins the hand, to the end of the fingers, was found best suited to most hands.

Each pupil was given several trials of strength and the best result obtainable was recorded. The curves of the strength of grip have been plotted on the same chart with weight, the better to show the relation of the development of strength and growth in weight. It will be seen from Table I. and Chart II. that the boys surpass the girls in strength at all ages; even in the kindergarten the average boy is stronger in his left hand than the average girl is in her right hand, and during the early years of adolescence this differentiation of the sexes becomes very striking. These facts were shown in Dr. Christopher's report and have been fully confirmed by the compilation from the larger numbers. The curve representing the strength of

the boy's left hand runs nearly parallel to the curve representing his growth in weight, and in the earlier years of adolescence the curve representing the strength of the right hand gradually approaches the curve of weight. With the girls the lines representing strength and weight gradually become farther and farther apart.

DEVELOPMENT OF VITAL CAPACITY.

The term vital capacity is used here to signify the amount of air that a person can expire after a forced inspiration.

Vital capacity was tested by means of a wet spirometer. In this test, as in the test of strength, the child was allowed repeated trials until he fell short of his previous efforts and the best mark attained was recorded. The boys show greater breathing capacity from the first, the difference becoming marked during adolescence. The great breathing capacities of the boys who were in training for foot ball and the girls who played basket ball were in strong contrast with those who took little physical exercise, which suggests that vital capacity increases and decreases with the amount of one's activity, and so, in connection with size, is an index of the rate of metabolism.

THE DEVELOPMENT OF ENDURANCE.

A modification of Mosso's ergograph made possible the study of endurance and fatigue. This instrument gives a graphic record and a measure of the work done under certain fixed conditions by a single group of muscles. The apparatus consists of two parts: a fixing board and a carriage with tracing apparatus mounted on a suitable frame. The arm is fastened firmly to the fixing board allowing free movement to only the middle finger of the right hand. To this finger a cord is fastened which, passing to the carriage and over a pulley at the end of the stand, is attached to a weight. In each case, in these tests, this weight was seven per cent of the weight of the individual. In flexing the finger the weight is lifted and on extending the finger the weight returns to its original place. A pen attached to the carriage and resting upon a kymograph, traces the movement thus made upon paper fastened to the revolving cylinder of the kymograph, and a moving tape line measures the distance which the weight has been lifted. This distance, multiplied by the weight, gives the amount of work done. By keeping time with the beating of a metronome, these flexions and extensions of the finger are made at regular intervals, so that in ninety seconds, the time employed in each test, the weight would be lifted forty-five times. In operating

the ergograph loaded thus with seven per cent of the gross weight of the individual, it was found that at some period between ninety and one hundred and fifty seconds such fatigue was usually produced as to render it impossible to move the weight at all. By limiting the work to ninety seconds a point was reached at which the strongest pupils would begin to show fatigue and only the weakest and very obese pupils became entirely exhausted. Chart IV. and Table I. show the development of endurance as shown by the power to do work on the ergograph. From this chart it appears that boys have greater endurance than girls at all ages and during adolescence the differentiation of the sexes becomes very striking. The charts of endurance and vital capacity bear a decided resemblance to each other. The comparison of the records an individual makes in endurance and vital capacity seems to show that they usually develop together.

DISTRIBUTION INTO PERCENTILE GROUPS.

Table V gives the distribution of the data, from the measurements, into percentile groups. Thus, of the four-year-old boys the shortest one measured was eighty-six centimeters in height, ten per cent of the boys were less than ninety-six centimeters tall, twenty-five per cent were below ninety-eight centimeters, seventy-five per cent below one hundred and four centimeters, ninety per cent below one hundred and seven centimeters, and the tallest four-year-old boy was one hundred and sixteen centimeters in height. It has been pointed out by W. Townsend Porter that this form of grouping affords a means of comparing the growth of the small and the large children. The criticism has been made that there is no assurance that a child who is small at one age is certain to be among the small pupils when he reaches another age. While children undoubtedly do pass at times from one group to another, still there is much reason to believe that Porter in the main is right. The percentile grouping is important here as showing the degree of homogeneity of the data collected. In this connection I would call attention to the variation in power among individuals during early adolescence.

Chart V is based on the percentiles of weight. It shows that the pubescent superiority of girls over boys occurs much earlier and continues for a longer period in the higher percentile groups than in the lower ones. This is in striking confirmation of Porter's compilations.

CHART V.

Weight of Pupils Distributed into Percentile Groups. The dotted lines represent the Girls; the solid lines the Boys.

Based on Data in Table V.

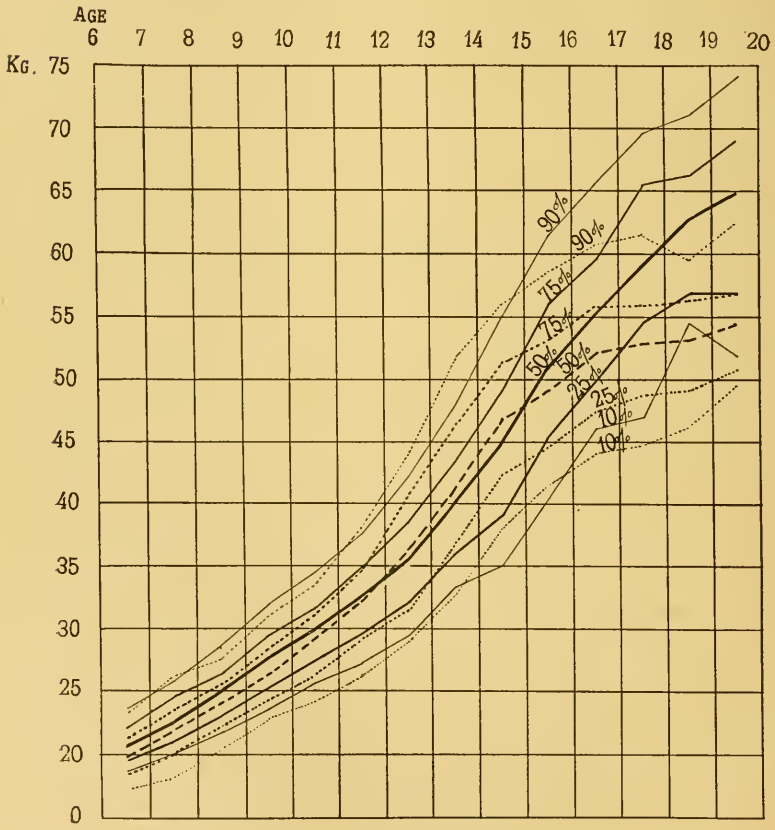


TABLE V. DISTRIBUTION INTO PERCENTILE GROUPS—Height.

BOYS.

AGE.	Minimum. cm.	10 Per Cent. cm.	25 Per Cent. cm.	75 Per Cent. cm.	90 Per Cent. cm.	Maximum. cm.
4	86	96	98	104	107	116
5	96	103	104	110 5	113.5	118
6	101	107	110	116	119.5	125
7	103	112	115	121.5	124.5	132
8	109	116.5	120	127	130	138
9	107	121	125	133	136.5	146
10	116	125.5	129	137.5	141.5	147
11	121	130	133.5	140	144.5	159
12	125	132.5	137	146	150:5	164
13	131	140	143.5	154	159	168
14	130	143.5	148.5	160	167.5	178
15	132	151	155.5	166.5	171.5	179
16	142	155.5	159	172.5	175.5	185
17	137	160.5	165.5	174	178.5	182
18	161	166.5	168	177	181.5	183
19	148	163	165.5	178	184	197

GIRLS.

4	92	96	98	104	106	110
5	93	100	102	111	114	118
6	95	106.5	109.5	116	118.5	128
7	103	111	114.5	121.5	124.5	133
8	105	116	119	126.5	129	140
9	115	120.5	124	132	135.5	143
10	115	125	128.5	136	140	147
11	119	129.5	134	142.5	146.5	155
12	121	134	139	149	153.5	163
13	129	140.5	145	155	159	170
14	126	147.5	151.5	159.5	163	169
15	140	150	153	160	163.5	172
16	144	150.5	154.5	162	165.5	177
17	144	152	155	162	165.5	177
18	137	151.5	155	162.5	166	176
19	143	152	156	163	167	169

DISTRIBUTION INTO PERCENTILE GROUPS—Weight.

BOYS.

AGE.	Minimum. Kg.	10 Per Cent. Kg.	25 Per Cent. Kg.	75 Per Cent. Kg.	90 Per Cent. Kg.	Maximum. Kg.
4	12	14.75	15.5	18	20.25	21
5	13	16.25	17	19.5	21	26
6	15	18.5	19.5	22 25	23.75	27
7	17	20	21	24.5	25.75	32
8	17	21 75	23	26.5	28.75	62
9	20	23.5	25.25	29.5	32	38
10	19	25.75	27.5	31.75	34.5	50
11	23	27.25	29.5	35	37.75	49
12	25	29.5	32.25	38.25	42.25	54
13	28	33.5	36	43.5	48	72
14	29	35	39	49	55	68
15	30	40 5	45.5	56	61.5	97
16	34	46	50	59.5	65.5	105
17	34	47	54.5	65.5	69.5	81
18	45	54 5	57	66	71	83
19	47	52	57	69	74	98

GIRLS.

4	12	14	15.5	17.5	19.25	21
5	13	15.25	16.5	19.25	21.25	23
6	13	17	18.25	21.5	23.25	27
7	15	18.25	20	23.5	26	31
8	17	20.5	22	25.5	27.5	35
9	19	22.75	24	28.5	31	41
10	19	24	26	31.25	33.5	50
11	21	26.5	29	34.75	38	50
12	21	29	31.75	40.5	44	69
13	24	33	36.5	46.5	52	69
14	28	38	42.5	51.75	56	74
15	30	41.5	44.5	53	58.25	81
16	33	44	47.5	56	60.75	91
17	38	44.5	48.25	56	61.5	75
18	35	46.25	49	56.5	59.5	80
19	38	49.5	51	57	62 5	88
20	30	46	48.5	59.5	66	71

DISTRIBUTION INTO PERCENTILE GROUPS—Right Hand Grip.

BOYS.

Age.	Minimum. Kg.	10 Per Cent. Kg.	25 Per Cent. Kg.	75 Per Cent. Kg.	90 Per Cent. Kg.	Maximum. Kg.
4	3	3.25	4	7.25	9	10.50
5	4	5.25	6	9.75	10.25	12
6	7	8.50	9.25	11.50	12.50	16
7	5	9.25	10.25	13.25	14.50	27
8	6	10	11.25	15.25	17.50	24
9	8	11.25	13.25	18.25	20.50	30
10	10	13.25	15.25	20.50	22.75	33
11	11	15.50	17.50	23	25.50	31
12	11	17.25	20	26	29	37
13	17	20.25	22.25	30.50	34.25	62
14	15	22	25	35.75	40.75	51
15	19.50	37	30.25	42	47.50	56
16	21	33	36.50	47.50	51	75
17	20	39	42	53.50	59	72
18	36	43.50	46.25	58	63	71
19	43	46.50	48	62	68	77
20	40	51	52	57.50	59	59

GIRLS.

4	3	4	4.50	7	8.75	9
5	3	4.50	5.50	8.25	10	12
6	4	7	8.50	10.50	12	14
7	5	9	10	12.25	13.75	16
8	6	9	10.25	13.50	15.25	18
9	8	10.50	12.25	15.75	18.25	24
10	9	11.50	13	18	20.50	32
11	8	13.25	15.25	20.50	23	27
12	10	15.25	17.50	23.50	27.50	35
13	11	18	20.25	27.50	30.75	45
14	14.50	20	22.50	31	33 50	38
15	16.50	22	25	31.50	34.50	47
16	18	23.50	26.50	32.50	36	48
17	18	24	26.50	33	37	45
18	22	24.50	27	32.50	36.25	46
19	20	25	27.50	33.50	36.50	39
20	21	26	28.50	34	35.50	36

DISTRIBUTION INTO PERCENTILE GROUPS—Vital Capacity.

BOYS.

Age.	Minimum. Cu. cm.	10 Per Cent. Cu. cm.	25 Per Cent. Cu. cm.	75 Per Cent. Cu. cm.	90 Per Cent. Cu. cm.	Maximum. Cu. cm.
4	500	625	675	825	950	1050
5	500	775	850	1025	1150	1250
6	700	925	1000	1225	1325	1600
7	700	1025	1150	1375	1475	1800
8	800	1150	1250	1575	1750	2100
9	950	1300	1400	1750	1925	2200
10	900	1350	1450	1850	2050	2700
11	1100	1475	1600	2025	2200	3000
12	1150	1575	1750	2200	2400	3100
13	1600	1850	2000	2450	2800	4200
14	1100	1900	2175	2900	3350	4000
15	1400	2250	2450	3300	3575	4500
16	2000	2550	2950	3800	4300	5100
17	1800	2900	3200	4000	4350	5000
18	2400	3225	3425	4175	4700	5000
19	3000	3100	3500	4200	4800	5600
20	2200	2100	3300	4600	5000	5100

GIRLS.

4	600	675	725	825	850	900
5	600	725	800	975	1025	1100
6	600	800	900	1175	1300	1400
7	750	925	1000	1250	1350	1600
8	700	1000	1125	1350	1450	1800
9	900	1125	1225	1500	1650	2100
10	900	1225	1325	1600	1800	2100
11	1000	1325	1450	1800	1950	2300
12	800	1400	1550	1975	2150	3000
13	1100	1600	1750	2175	2400	3000
14	1350	1700	1925	2350	2675	3100
15	1450	1850	2000	2450	2675	3400
16	1350	1925	2100	2550	2750	3600
17	1250	1900	2075	2550	2800	3300
18	1500	1950	2150	2660	2800	3600
19	1700	2000	2200	2700	3000	3300
20	1300	1900	2200	2700	2825	2900

DISTRIBUTION INTO PERCENTILE GROUPS—Ergograph.

BOYS.

Age.	Minimum. kg.-cm.	10 Per Cent. kg.-cm.	25 Per Cent. kg.-cm.	75 Per Cent. kg.-cm.	90 Per Cent. kg.-cm.	Maximum. kg.-cm.
5	50	52.5	55	100	130	150
6	30	62.5	77.5	127.5	150	230
7	40	92.50	115	165	190	280
8	40	110	135	200	227.5	300
9	50	140	167.5	142.5	187.5	390
10	110	162.5	190	272.5	315	520
11	110	190	222.5	295	365	490
12	100	202.5	242.5	347.5	402.5	580
13	130	230	285	405	490	880
14	160	265	332.5	510	585	880
15	150	320	390	615	745	1040
16	260	410	470	680	775	1320
17	230	440	545	770	855	1110
18	380	560	600	790	905	1010
19	390	520	610	850	1040	1140

GIRLS.

5	20	30	45	70	90	100
6	30	60	75	117.5	142.5	200
7	40	75	95	145	170	280
8	30	90	112	170	195	280
9	50	11	137.5	202.5	230	430
10	40	125	155	225	260	600
11	70	150	175	260	305	390
12	70	165	195	285	350	650
13	80	185	225	355	430	570
14	90	215	227.5	405	480	660
15	100	230	290	415	480	690
16	120	232.5	305	442.5	530	840
17	150	230	292.5	430	520	640
18	130	240	300	450	510	820
19	160	270	340	480	575	870

THE RATE OF ANNUAL INCREASE IN GROWTH AND DEVELOPMENT.

Table VI. shows separately for each sex and for each of the physical measurements taken the following points: First, the special measurement under consideration at the beginning of each year, as shown in the table of exact birthday norms. Second, the increase in that measurement found at the beginning of the next year or the increment during that year. Third, the per cent that this increment is of the measurement at the beginning of the year during which it has occurred.

The per cents of gain in height, weight, strength, endurance, and vital capacity are represented in Charts VI. and VII. The study of these charts and tables leads to some interesting and important considerations. Noting first the chart relating to the annual rate of gain in height, it is seen that the general trend of this rate of increase is downward. This general trend is broken in both sexes by a rise, which in girls commences at ten and ends at sixteen, and in boys commences at twelve and ends at seventeen. The summits of these rises are from twelve to fourteen in girls and from thirteen to sixteen in boys. The curve showing the rate of gain in weight shows a similar rise in both sexes with maxima at the same ages as in the case of height. The superiority of girls over boys in gain in height and weight at this period of life is also shown. When the curves of the increments of the strength of grip of the right hand, vital capacity, and endurance are observed, it is seen that there is a similar increase at the same ages. The period of the superiority of girls over boys in rate of increase in these latter measurements, all of which involve the factor of physical power which is less at all ages in girls than in boys, is not so great nor so long maintained as in the case of height and weight. However, the finer differences in rate of growth and development between the sexes are not of special import to us

CHART VI.

Rate of Annual Increase in Stature, Weight, and Strength of Grip.

Based on Data in Table VI.

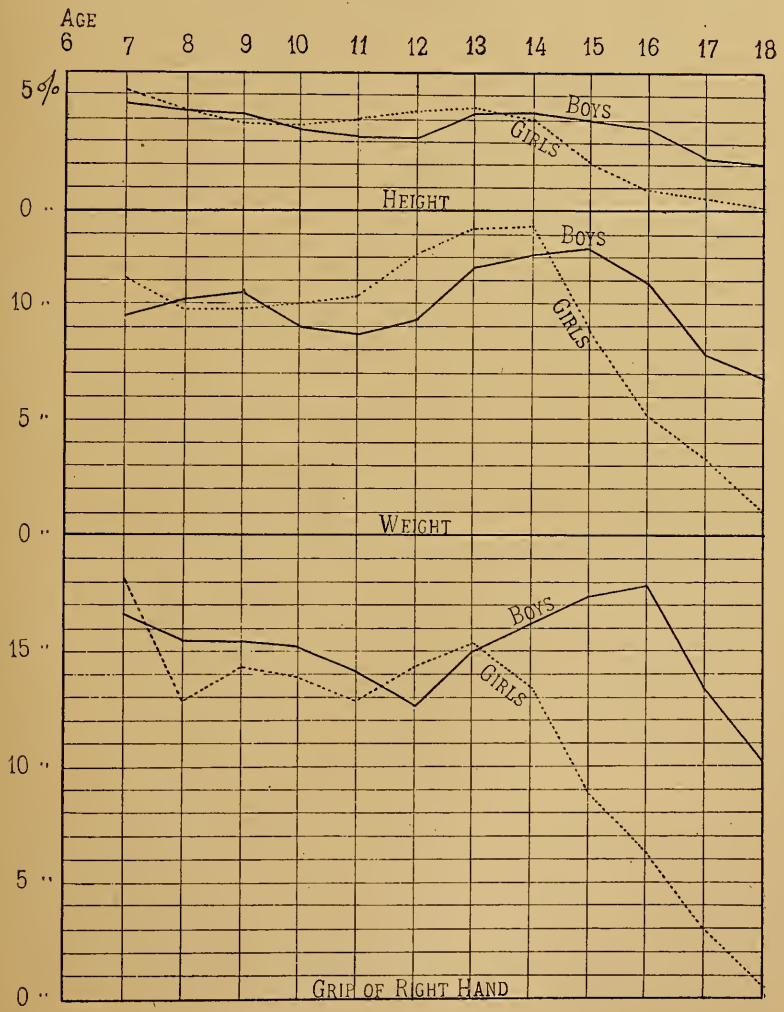
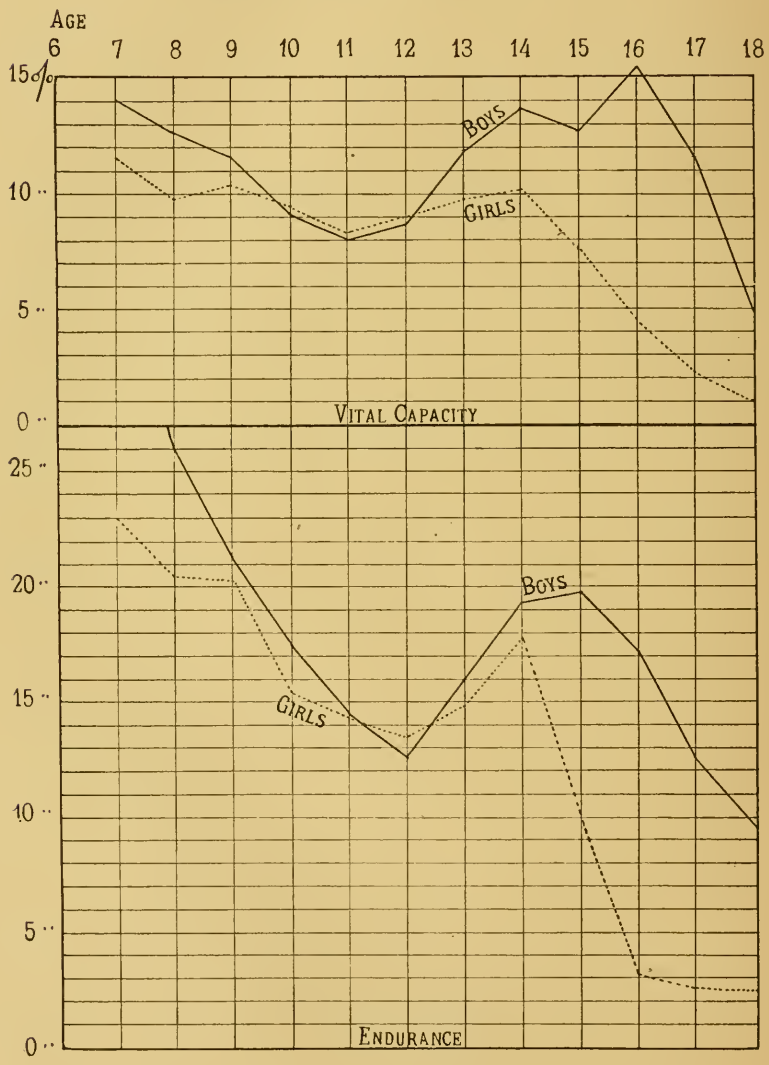


CHART VII.

Rate of Annual Increase in Vital Capacity and Endurance.

Based on Data in Table VI.



at present. The great feature for consideration is this: There is an exaltation of life processes at the pubescent period which finds its expression not only in an increased rate of growth but also in the development of physical power.

Education has as its basis the bringing about of bodily changes, especially the modification of the central nervous system. The period of growth of any organ is the period of its plasticity. Although this is not the period of most rapid increase in weight of the nervous system, the rapid development of physical power would in itself indicate that it is a period of nervous change. The question may now be asked: Is this pubescent exaltation, shown so markedly in the physical elements of child life, characteristic also of the other features of that life? In other words, is there a corresponding exaltation of the intellectual and emotional features of the child life? It is unquestionably true that at this period the emotions are in a relatively high state of exaltation, and that many neuroses appear, according to the observations of well trained alienists and neurologists.

It is undoubtedly a period of great plasticity, physical, mental and moral, a period when great changes occur rapidly. The already well-established relationship existing between physical and intellectual life justifies us in believing that at this period the intellectual turmoil is as great as the physical and emotional. It therefore seems to be the period in school life when the child organism is not only most in need of, but most susceptible to, educational influences. It may not follow that it is a time when the greatest amount of intellectual work should be put upon the child, but it certainly is the great period for *character formation*. At no time in the whole school life of the child is judicious, intelligent, and sympathetic educational guidance so necessary and so useful.

There is also another feature of the pubescent period of life no less important than the general law of exaltation of physical, mental, and moral processes. This feature is the matter of the exceptions to this law. In the report of last year (Charts XIII. to XVII.) there was shown to exist a wide range in all the physical measurements of pupils in the upper grammar grades. In the present report an examination of the tables of percentiles will reveal a similar tendency to extreme range of measurements in the outer percentiles in the pubescent years. The significance of these facts seems to be that in the pubescent period a larger per cent of individuals than usual pass beyond the normal limits set by the mass. Furthermore, this passing is in both directions, upward and downward. In other words, while pubescence is a period of great exaltation of the mass of childen it is also a period of high individualization, a period when the weak fail and the able forge

to the front. Such a fact is of fundamental importance in education and demands rational and extensive elasticity in the school work at this period of life.

At this period a large number of pupils drop out of school. Is this the fault of the curriculum? The high physical averages found in the following years seems to indicate that the weaker ones are those who leave school at this time. This is a question of great pedagogic and social import and should receive further attention.

The charts seem to show also that a similar but less well marked period of activity is present from the beginning of school life to the age of nine.

Table VI.

ANNUAL RATE OF INCREASE—BOYS.

Age.	Height at Beginning of Year. Mm.	Amount of Gain. Mm.	Per Cent of Gain.
6 to 7	1106.9	51.3	4.63
7 to 8	1158.2	51.1	4.40
8 to 9	1209.3	52.1	4.30
9 to 10	1261.4	47.7	3.77
10 to 11	1309.1	42.0	3.20
11 to 12	1351.1	44.3	3.27
12 to 13	1395.4	60.0	4.29
13 to 14	1455.4	63.8	4.39
14 to 15	1519.2	61.5	4.04
15 to 16	1580.7	59.6	3.70
16 to 17	1640.3	38.2	2.32
17 to 18	1678.5	33.8	2.01

Age.	Height Sitting at Beginning of Year. Mm.	Amount of Gain. Mm.	Per Cent of Gain.
6 to 7	624.0	22.7	3.64
7 to 8	646.7	20.8	3.21
8 to 9	667.5	20.4	3.05
9 to 10	687.9	17.7	2.57
10 to 11	705.6	15.4	2.18
11 to 12	721.0	17.0	2.35
12 to 13	738.0	24.4	3.30
13 to 14	762.4	29.7	3.89
14 to 15	792.1	29.7	3.74
15 to 16	821.8	32.5	3.95
16 to 17	854.3	27.3	3.19
17 to 18	881.6	21.4	2.41

Age.	Weight at Beginning of Year. Kg.	Amount of Gain. Kg.	Per Cent of Gain.
6 to 7	19.738	1.875	9.50
7 to 8	21.613	2.204	10.20
8 to 9	23.817	2.519	10.57
9 to 10	26.336	2.371	9.00
10 to 11	28.707	2.516	8.76
11 to 12	31.223	2.928	9.37
12 to 13	34.151	3.933	11.51
13 to 14	38.084	4.612	12.11
14 to 15	42.696	5.297	12.40
15 to 16	47.993	5.245	10.92
16 to 17	53.238	4.146	7.78
17 to 18	57.384	3.904	6.80

Age.	Ergograph at Beginning of Year. Kg.-Cm.	Amount of Gain. Kg.-Cm.	Per Cent of Gain.
6 to 7	87.47	34.65	39.62
7 to 8	122.12	32.05	26.24
8 to 9	154.17	32.90	21.34
9 to 10	187.07	32 96	17.56
10 to 11	220.03	31.83	14.46
11 to 12	251.86	31 97	12.68
12 to 13	283 83	45.38	15.98
13 to 14	329.21	63.41	19.29
14 to 15	392.62	77.51	19.74
15 to 16	470.13	81.09	17.23
16 to 17	551.22	69.42	12.59
17 to 18	620.64	59.09	9.52

Age.	Right Hand Grip at Beginning of Year. Kg.	Amount of Gain. Kg.	Per Cent of Gain.
6 to 7	9.21	1.53	16.61
7 to 8	10.74	1.67	15.55
8 to 9	12.41	1.93	15.55
9 to 10	14.34	2.18	15.20
10 to 11	16.52	2.33	14.10
11 to 12	18.85	2.39	12.67
12 to 13	21.24	3.20	15.06
13 to 14	24.44	3.98	16 28
14 to 15	28.42	4.97	17.44
15 to 16	33.39	5.98	17.90
16 to 17	39.37	5.37	13.38
17 to 18	44.14	4.54	10.14

Age.	Left Hand Grip at Beginning of Year. Kg.	Amount of Gain. Kg.	Amount of Gain.
6 to 7	8.48	1.63	19.22
7 to 8	10.11	1.56	15.43
8 to 9	11.67	1.80	15.42
9 to 10	13.47	2.12	15.73
10 to 11	15.59	2.13	13.66
11 to 12	17.72	1.99	11.23
12 to 13	19.71	2.80	14.20
13 to 14	22.51	3.71	12.03
14 to 15	26.22	4.66	17.77
15 to 16	30.38	5.51	17.84
16 to 17	36.39	4 57	12.55
17 to 18	40.96	4.05	9.88

Age.	Vital Capacity at Beginning of Year. Cu. cm.	Amount of Gain. Cu. cm.	Amount of Gain.
6 to 7	1023	145	14.17
7 to 8	1168	148	12.67
8 to 9	1316	153	11.62
9 to 10	1469	134	9.12
10 to 11	1603	129	8.04
11 to 12	1732	151	8.71
12 to 13	1883	225	11.95
13 to 14	2108	287	13.61
14 to 15	2395	302	12.60
15 to 16	2697	423	15.68
16 to 17	3120	363	11.63
17 to 18	3483	172	4.93

ANNUAL RATE OF INCREASE—GIRLS.

Age.	Height at Beginning of Year. Mm.	Actual Gain. Mm.	Per Cent of Gain.
6 to 7	1096.6	57.1	5.20
7 to 8	1153.7	51.2	4.44
8 to 9	1204.9	47.5	3.94
9 to 10	1252.4	48.3	3.86
10 to 11	1300.7	52.8	4.06
11 to 12	1353.5	59.6	4.40
12 to 13	1413.1	63.7	4.51
13 to 14	1476.8	59.6	4.04
14 to 15	1536.4	31.9	2.08
15 to 16	1568.3	14.7	0.94
16 to 17	1583.0	9.6	0.61
17 to 18	1592.6	1.6	0.10

Age.	Height Sitting at Beginning of Year. Mm.	Actual Gain. Mm.	Per Cent of Gain.
6 to 7	617.0	23.7	3.84
7 to 8	640.7	22.7	3.54
8 to 9	663.4	19.8	2.98
9 to 10	683.2	17.3	2.53
10 to 11	700.5	21.8	3.11
11 to 12	722.3	27.0	3.74
12 to 13	749.3	29.8	3.98
13 to 14	779.1	30.8	3.95
14 to 15	809.9	22.2	2.74
15 to 16	832.1	13.3	1.60
16 to 17	845.4	6.6	0.78
17 to 18	852.0	3.1	0.36

Age.	Weight at Beginning of Year. Kg.	Actual Gain. Kg.	Per Cent of Gain.
6 to 7	18.870	2.104	11.15
7 to 8	20.974	2.036	9.71
8 to 9	23.010	2.247	9.77
9 to 10	25.257	2.538	10.05
10 to 11	27.795	2.867	10.31
11 to 12	30.662	3.711	12.10
12 to 13	34.373	4.601	13.38
13 to 14	38.974	5.245	13.46
14 to 15	44.219	3.942	8.91
15 to 16	48.161	2.491	5.17
16 to 17	50.652	1.734	3.42
17 to 18	52.386	0.537	1.03

Age.	Ergograph at Beginning of Year. Kg.-Cm.	Actual Gain. Kg.-Cm.	Per Cent of Gain.
6 to 7	87.79	20.21	23.02
7 to 8	108.00	22.24	20.59
8 to 9	130.24	26.49	20.34
9 to 10	156.73	24.25	15.47
10 to 11	180.98	25.92	14.32
11 to 12	206.90	28.02	13.55
12 to 13	234.92	34.97	14.89
13 to 14	269.89	48.23	17.87
14 to 15	318.12	31.71	9.97
15 to 16	349.83	11.27	3.22
16 to 17	361.10	9.64	2.67
17 to 18	370.74	9.63	2.60

Age.	Right Hand Grip at Beginning of Year. Kg.	Amount of Gain. Kg.	Per Cent of Gain.
6 to 7	8.36	1.52	18.18
7 to 8	9.88	1.28	12.96
8 to 9	11.16	1.61	14.43
9 to 10	12.77	1.78	13.94
10 to 11	14.65	1.89	12.95
11 to 12	16.54	2.38	14.39
12 to 13	18.92	2.92	15.43
13 to 14	21.84	2.95	13.52
14 to 15	24.79	2.21	8.91
15 to 16	27.00	1.70	6.30
16 to 17	28.70	0.86	3.00
17 to 18	29.56	0.19	0.6

Age.	Left Hand Grip at Beginning of Year. Kg.	Amount of Gain. Kg.	Per Cent of Gain.
6 to 7	7.74	1.50	19.37
7 to 8	9.24	1.24	13.42
8 to 9	10.48	1.49	14.21
9 to 10	11.97	1.75	14.62
10 to 11	13.72	1.80	13.11
11 to 12	15.52	2.26	14.56
12 to 13	17.78	2.61	14.66
13 to 14	20.39	2.53	12.40
14 to 15	22.92	2.00	8.72
15 to 16	24.92	1.64	6.58
16 to 17	26.56	0.87	3.27
17 to 18	27.43	0.23	0.85

Age.	Vital Capacity at Beginning of Year. Cu. cm.	Amount of Gain. Cu. cm.	Per Cent of Gain.
6 to 7	950	111	11.68
7 to 8	1061	104	9.80
8 to 9	1165	121	10.39
9 to 10	1286	123	9.56
10 to 11	1409	117	8.30
11 to 12	1526	138	9.04
12 to 13	1664	163	9.79
13 to 14	1827	187	10.24
14 to 15	2014	154	7.64
15 to 16	2168	98	4.52
16 to 17	2266	53	2.34
17 to 18	2319	24	1.03

THE PHYSICAL CONCOMITANTS OF DULLNESS AND PRECOCITY.

The tests mentioned so far are physical, but mental tests made by the teachers have been going on daily for years and the pupils have been graded on an intellectual basis; and the psychological value of the tests is brought out when we compare the intellectual standing of the pupil with the result of the physical tests. For example, the twelve-year-old pupils are scattered throughout the grades of the elementary schools. Some are found in the second grade, some in the third, some in the fourth, some in the fifth, some in the sixth, some in the seventh and some in the eighth. On compiling the results of the physical tests it is found that the twelve-year-old pupils of the higher grades are decidedly superior in stature, weight, strength, endurance, and vital capacity to those found in the lower grades, as shown by Table VII and Charts VIII, IX, X, XI, and XII. In Dr. Christopher's preliminary report (pp. 14 to 24) similar tables and charts were given in demonstration of this problem originally set forth in reference to height and weight by W. Townsend Porter. They were based upon the examination of only 138 pupils of the age of twelve and 126 of the age of eleven. The charts here given are based upon the examination of 497 pupils of the age of twelve. The larger number of pupils serves to straighten out the curves and relieve them of much of the irregularity which small numbers are liable to produce. To show how decidedly this parallelism between physical superiority and mental capacity exists throughout school life the pupils have been divided into two groups, those at or above the normal grade for that age, representing the brighter pupils, and those below the normal grade for that age, representing the backward pupils. The normal grade for a given age was found by subtracting six from the age; thus, a pupil of twelve years would normally be found in the sixth grade; if in the fifth or lower grade he would be classed as below grade; if in the sixth, seventh, or eighth, he would be

classed as at or above grade. The results of this compilation will be seen in Table VIII and Charts XIII, XIV, XV, and XVI.

That those below grade approach so closely to those at or above grade will be readily understood when we consider that the great majority of all the pupils are but little above or below grade, that is, but little removed from their normal grade.

The falling off of the lines representing those at or above grade in the charts of school standing in the upper ages, and also the decline of the lines of the last years of the charts of norms will naturally be explained on this basis. A few of the very brightest pupils, and so among the very best specimens physically for their age, graduate from the high school as early as sixteen and so leave a lowering of the average of the pupils found in the schools at seventeen and eighteen years and onward.

This demonstration of the physical superiority of the more intelligent pupils does not necessarily imply that small or weak men are always less efficient mentally than are large men, but it does seem to show that one is likely to attain to his highest mental development only as he reaches the physical growth and development which nature has marked out for him. It suggests that those in charge of children should see that the normal conditions of growth and development are not interfered with. To the parent it suggests that he should keep wide open the path of growth for the child by securing the best conditions of food, shelter, and immunity from disease. Teachers are liable to interfere with the conditions of growth and development by subjecting the pupils to over stimulation, bad air, improper temperatures, and too limited an amount of physical exercise. Everywhere it should be borne in mind that childhood should be sacred to growth and development.

TABLE VII. TWELVE-YEAR-OLD PUPILS BY GRADES.

GRADE.	No. Ex.	Av. Age.	Av. Ht. mm.	Av. Wt. kg.	Av. Erg. kg.-cm.	Av. Strength of Grip. Right Hand. kg.	Av. Strength of Grip. Left Hand. kg.	Av. Vital Capacity. cu. cm.
II	4	12-3-28	1333	29.513	233	16.75	16.50	1488
III	19	12-5-23	1377	33.592	248.7	20.03	18.55	1732
IV	84	12-5- 2	1403	34.972	271.3	20.22	18 85	1742
V	134	12-5- 9	1422	35.596	268	21.06	19.64	1790
VI	143	12-5-20	1443	36.136	271	21.40	20.12	1887
VII	95	12-6-13	1451	37.150	283	22.31	20.41	1947
VIII	18	12-6-29	1443	38.453	318.6	23.31	21.07	3053

CHART VIII.

Stature and School Standing.

Based on Data in Table VII.

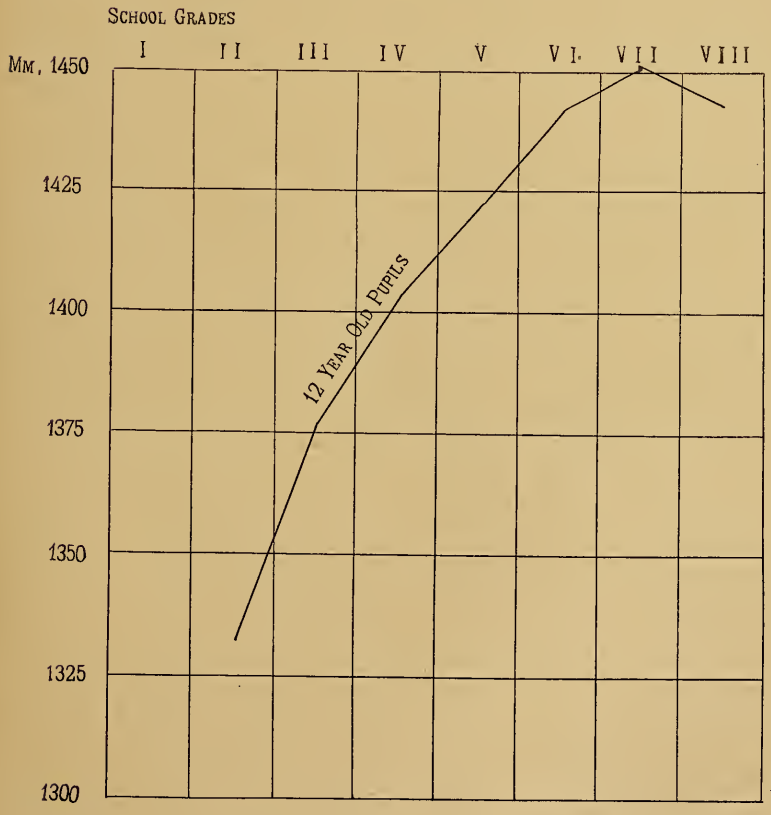


CHART IX.

Weight and School Standing.

Based on Data in Table VII.

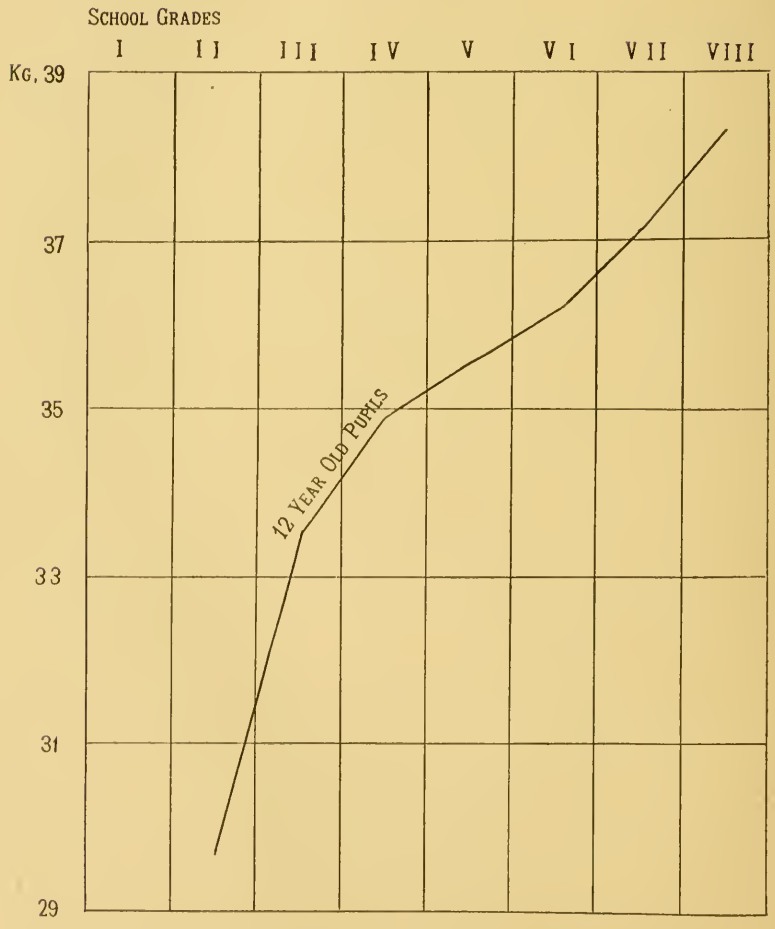


CHART X.

Strength of Grip and School Standing.

Based on Data in Table VII.

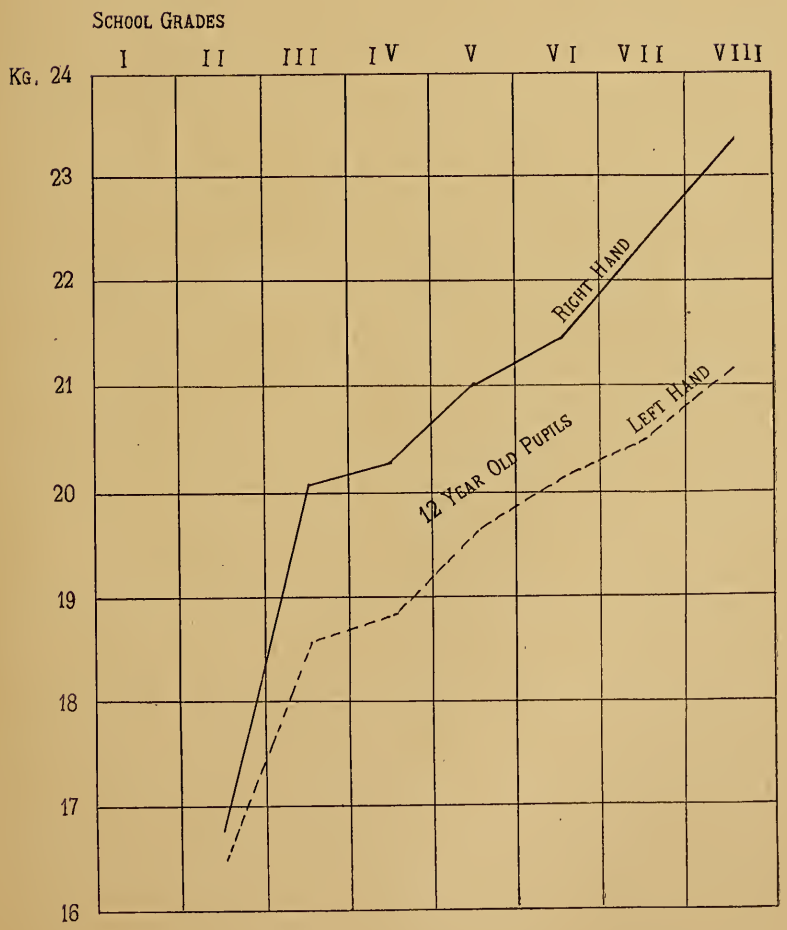


CHART XI.

Endurance and School Standing.

Based on Data in Table VII.

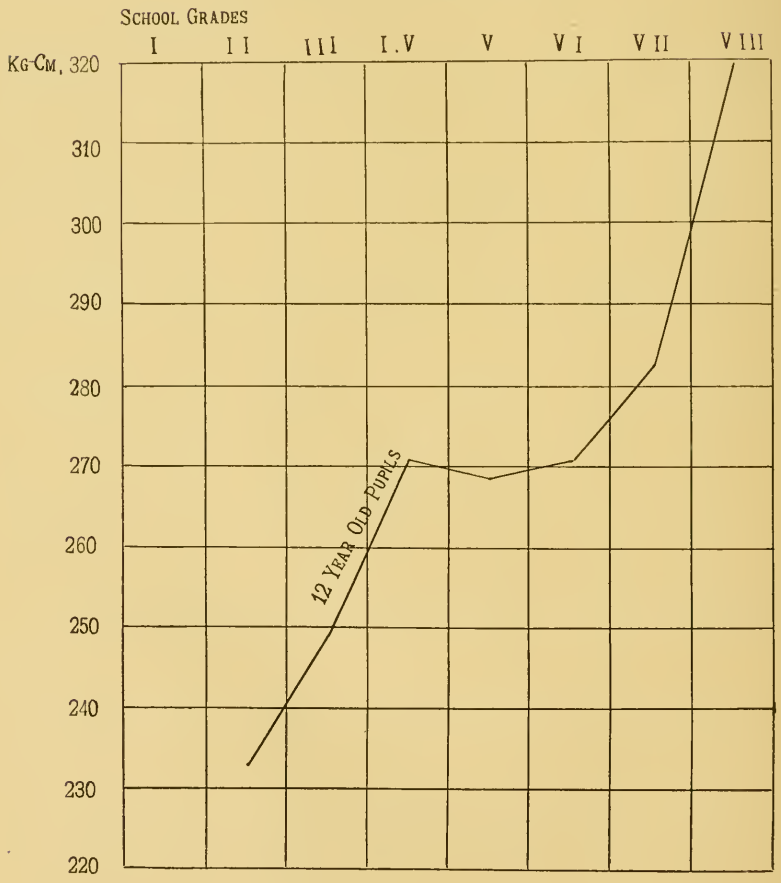


CHART XII.

Vital Capacity and School Standing.

Based on Data in Table VII.

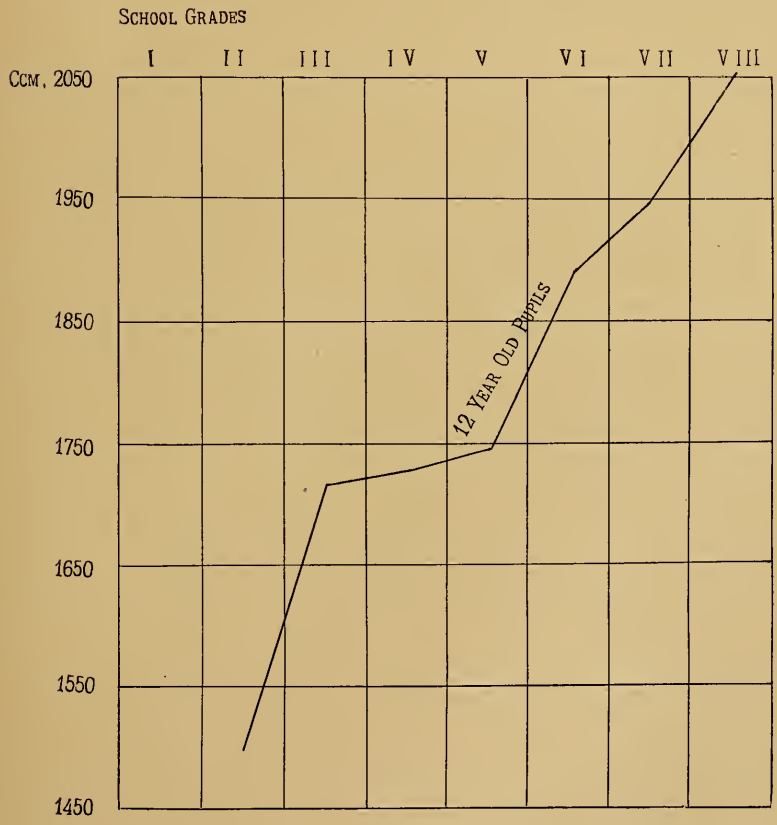


CHART XIII.

Stature and School Standing of Boys.

Based on Data in Tables VIII. and IX.

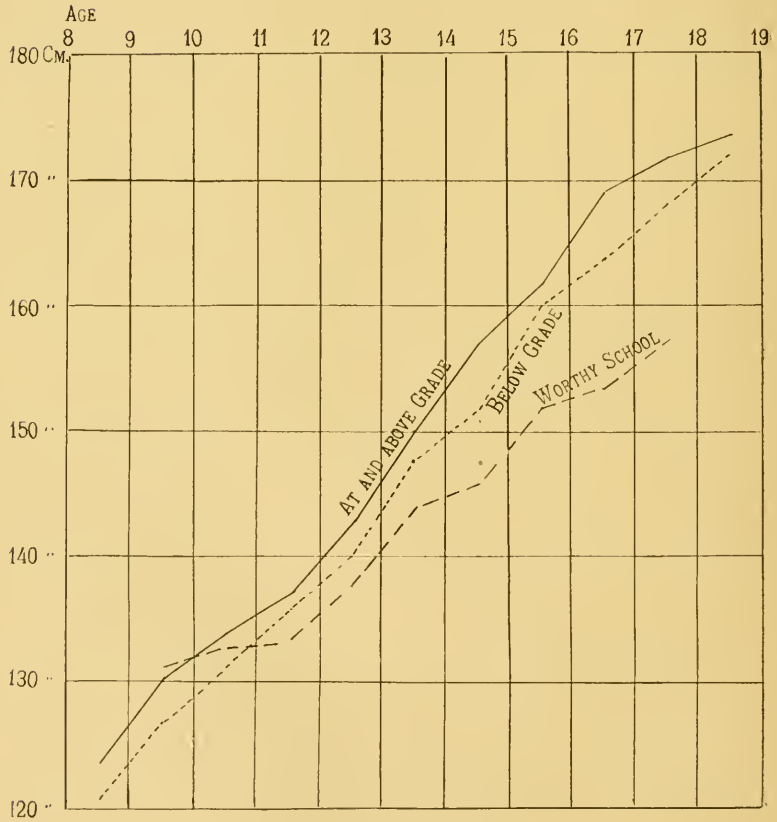


CHART XIV.

Weight and School Standing of Boys.

Based on Data in Tables VIII. and IX.

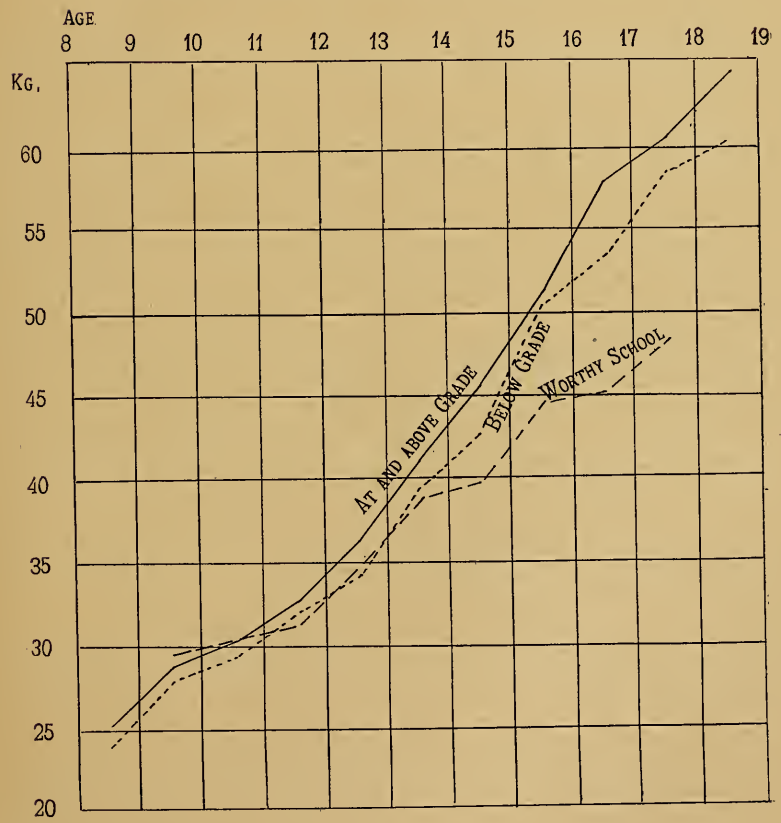


CHART XV.

Vital Capacity and School Standing of Boys.

Based on Data in Tables VIII. and IX.

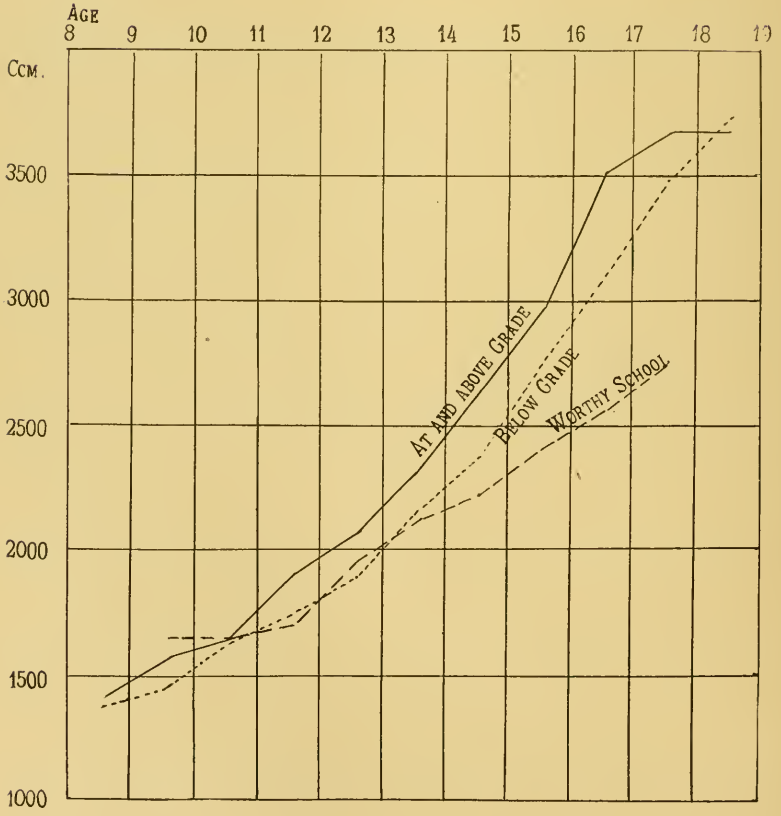


CHART XVI.

Endurance and School Standing of Boys.

Based on Data in Tables VIII. and IX.

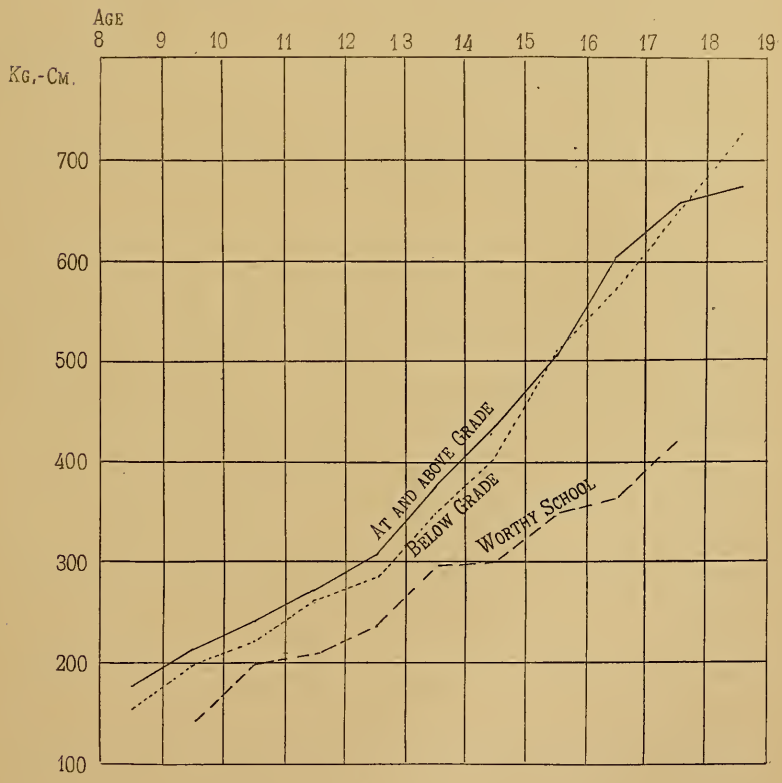


TABLE VIII. PHYSICAL DEVELOPMENT AND SCHOOL STANDING.

BOYS.

AGE.	NUMBER TESTED.	Average Age.	Height Stand'g mm.	Height Sitting. mm.	Weight. kg.	Ergograph. kg.-cm.	Right Grip. kg.	Left Grip. kg.	Vital Capacity. cu. cm.
8	At and above grade.....210	8-5-25	1238	679	25.286	170.1	13.46	12.49	1395
	Below..... 45	8-4-12	1210	667	23.790	155.2	12.05	11.68	1353
9	At and above grade.....151	9-6-21	1300	702	27.907	209.4	16.12	15 32	1588
	Below..... ... 77	9-5-2	1264	692	26.787	198.2	14.59	13.66	1472
10	At and above grade.....158	10-6-1	1340	717	30.258	240.5	17.84	16.62	1670
	Below..... 96	10-5-25	1314	707	29.145	225.7	17.42	16.52	1642
11	At and above grade.....125	11-6-23	1376	731	32.814	270.6	20.05	18.64	1828
	Below..... 103	11-5-25	1363	727	32.180	264.1	19.82	18.82	1766
12	At and above grade.....130	12-6-10	1436	754	36.843	306.6	23.38	21.44	2063
	Below.....126	12-5-4	1399	740	34.370	286.2	21.38	19.70	1844
13	At and above grade.....117	13-6-18	1500	782	41.470	372.4	27.42	24.98	2334
	Below.....113	13-5-1	1475	771	39.040	341.5	25.07	23.38	2163
14	At and above grade.....146	14-6-3	1564	815	46.218	437.3	30.69	28.31	2638
	Below.....104	14-5-2	1520	793	42.775	404.9	29.13	27.05	2360
15	At and above grade.....125	15-5-26	1622	843	51.394	507.8	36.64	33.54	2978
	Below..... 80	15-5-23	1599	827	50.369	515.9	35.79	33.40	2749
16	At and above grade..... 77	16-5-28	1689	881	58.246	606.8	43.21	39.86	3542
	Below..... 69	16-4-25	1637	859	53.289	575.7	40.90	37 69	3165
17	At and above grade..... 46	17-5-14	1702	897	60.417	654.	47.57	43.60	3646
	Below..... 46	17-5-24	1677	884	58.069	648.7	46.23	41.89	3495
18	At grade..... 23	18-5-27	1737	917	60.971	670.	50.53	44 82	3644
	Below..... 17	18-4-3	1726	911	64.252	723.8	51.41	48.17	3741

GIRLS.

8	At and above grade.....187	8-6-10	1236	677	24.373	147.4	11.89	11.16	1238
	Below..... 45	8-4-26	1195	662	22.424	120.2	10.73	10.08	1113
9	At and above grade.....156	9-6-15	1283	693	26.862	174.9	13.94	12.97	1381
	Below..... 65	9-4-29	1266	688	25.769	163.	13.77	13.12	1308
10	At and above grade.....157	10-6-5	1330	711	29.289	193.4	15.61	14 62	1452
	Below..... 83	10-4-5	1308	704	28.365	183 8	14.91	13 98	1465
11	At and above grade.....121	11-5-25	1390	738	32.651	223.7	18.04	17.16	1611
	Below.....102	11-5 5	1370	731	31.516	219.3	17.	15.87	1560
12	At and above grade.....132	12-5-27	1456	767	36.655	252.4	20.38	19.12	1763
	Below.....115	12-5-10	1423	756	35.958	244 2	19.77	18.69	1675
13	At and above grade.....154	13-7-3	1526	803	42.673	296.3	23.94	22.10	1939
	Below.....101	13-5-13	1492	788	40 036	291.8	23.08	21.60	1901
14	At and above grade.....226	14-6-20	1572	833	48.060	347.6	26.41	24.22	2160
	Below..... 75	14-5-23	1539	802	44.532	332.9	25.53	23.81	1986
15	At and above grade.....314	15-6-9	1576	842	49.745	360.7	28.09	25.96	2255
	Below..... 65	15-4-24	1564	831	47.413	336.2	27.09	25.07	2083
16	At and above grade.....182	16-6-19	1599	855	53.091	389.3	30.01	27.79	2340
	Below.....172	16-4-23	1584	848	50.773	405.7	28.95	26.80	2267
17	At and above grade.....132	17-5-29	1602	855	53.039	373.4	29.97	27.23	2331
	Below.....119	17-5-1	1590	851	51.663	366.5	29.23	26.97	2274
18	At grade..... 63	18-5-2	1597	856	53.214	387.2	30 15	27.84	2396
	Below..... 74	18-4-19	1594	858	52.846	376.7	29.57	27.69	2311

TEST OF THE PUPILS OF THE JOHN WORTHY SCHOOL

Near the close of the school year the apparatus was taken to the John Worthy School, the school in connection with the Bridewell, and the inmates, 284 in number were examined. Table and Charts XIII., XIV., XV. and XVI. show the results of these tests, and how these results compare with the averages made by the boys of the other schools. These pupils are found

to be inferior in all the principal measurements taken, and this inferiority seems to increase with age.

TABLE IX. COMPARISON OF THE JOHN WORTHY AVERAGES WITH THE NORMS.

NET HEIGHT.

AGE.	No.	John Worthy Average.	Normal.	Per Cent John Worthy Is of Normal.
		mm.	mm.	
9	2	1312	1289	101.78
10	10	1303	1330	97.97
11	24	1335	1370	97.45
12	54	1378	1418	97.19
13	47	1435	1488	96.44
14	65	1458	1546	94.32
15	51	1518	1613	94.04
16	24	1535	1665	92.19
17	7	1573	1690	93.07

HEIGHT SITTING.

		mm.	mm.	
9	2	704	699	100.77
10	10	710	713	99.57
11	24	715	729	98.07
12	54	736	747	98.52
13	47	755	777	97.04
14	65	771	806	95.65
15	51	774	837	92.47
16	24	795	871	91.27
17	7	819	891	91.91

WEIGHT.

		kg	kg.	
9	2	29.075	27.616	105.28
10	10	30.333	29.837	101.63
11	24	31.527	32.519	96 95
12	54	34.723	35.626	97.47
13	47	38.366	40 276	95.26
14	65	39.287	44.786	87.72
15	51	44.671	50.994	87.60
16	24	45.109	55.219	81.69
17	7	48.079	59.343	81.15

ERGOGRAPHIC WORK.

		kg.-cm.	kg.-cm.	
9	2	144.4	205.6	70.03
10	10	198.4	235.0	84.51
11	24	211.9	267.7	79.15
12	54	235.4	297.8	79.04
13	47	294.6	359.2	82.01
14	65	300.0	423.8	70.78
15	51	349.2	513.5	68.00
16	24	366.3	584.7	62.64
17	7	422.9	651.4	64.92

VITAL CAPACITY.

		cu. cm.	cu. cm.	
9	2	1675	1549	108.13
10	10	1673	1659	100.81
11	24	1694	1799	94.11
12	54	1953	1956	99.85
13	47	2098	2246	93.40
14	65	2203	2527	87.16
15	51	2409	2858	84.21
16	24	2541	3363	75.14
17	7	2750	3570	77.03

GRIP.

Age.	Number.	Right.			Left.		
		John Worthy. kg.	Normal. kg.	John Worthy. Per Cent.	John Worthy. kg.	Normal. kg.	John Worthy. Per Cent.
9	2	14.25	15.39	92.59	13.75	14.54	94.56
10	10	15.30	17.68	86.31	14.80	16.66	89.43
11	24	18.10	19.94	91.37	17.20	18.72	91.88
12	54	18.90	22.40	84.37	18.30	20.58	88.92
13	47	22.22	26.26	84.61	20.89	24.23	86.21
14	65	22.70	30.70	73.93	21.85	27.94	78.20
15	54	25.62	36.30	70.57	24.48	33.65	72.74
16	24	27.88	42.12	66.19	27.27	38.82	70.24
17	7	31.20	46.99	66.39	31.43	42.74	73.53

RIGHT-HANDEDNESS.

Educators have long been divided on the question of the desirability of attempting to develop ambidexterity in their pupils. One class maintains that "all want of perfect bilateral symmetry looks away from perfect sanity," that ambidexterity is the ideal condition, both in regard to the perfection of development and utility. The other class maintains that a high development can be given to one hand only, that the left hand plays the most useful part when it aids and supplements the action of the right. Most physical exercises prescribed for pupils from the kindergarten through the high school have aimed at overcoming the tendency to right-handedness, while penmanship and manual training have yielded to this tendency. This question, like most educational questions, can be rightly settled only upon the basis of child-study investigation.

In the absence of any term corresponding to ambidexterity, and meaning unequal ability in the use of the hands without indication of which hand is the superior, the term unidexterity is suggested.

Reference to Table I. and Chart II. shows that the children on the average are unidextrous, with the right hand superior at the time they enter school, and that the unidexterity increases during the early years of adolescence. It has long been known by those who have made a study of the localization of cerebral function that there is a connection between unidexterity and speech. J. Mark Baldwin from a study of his children has discovered a parallelism between the beginning of unidexterity and the beginning of speech in the development of the child. Does not the pubescent increase in unidexterity parallel the change of voice? In his report of last year (page 14 of the reprint), Dr. Christopher intimated that the marked differentiation in the strength of the hands is a pubescent change, but the small number of pupils involved in the exami-

nation, and the consequent irregularities in the curves, forbade a definite assertion to that effect. The larger numbers involved in the present discussion justify the definite conclusion that the phenomenon is a true law of child life.

A glance at Table VII and Chart X will show that the more advanced of the twelve-year-old pupils are more decidedly unidextrous than are the backward pupils of that age. That this association between decided unidexterity and intellectual power holds good throughout school life will be seen by a reference to Table X and Chart XVII. The apparent exception of the sixteen-year-old pupils disappears if the records of the left-handed pupils be excluded. The John Worthy boys too are more nearly ambidextrous on the average than are even the dull pupils. Among the left-handed pupils at or above grade, the average strength of grip of the right hand is 91.8 per cent of the strength of the left. Of the left-handed pupils below grade, the strength of the right hand is 94 per cent of that of the left. On the whole, the brightest are more decidedly unidextrous than are the average pupils, the average pupils are more unidextrous than are the dull pupils, and they in turn are more decidedly unidextrous than are the pupils of the John Worthy School.

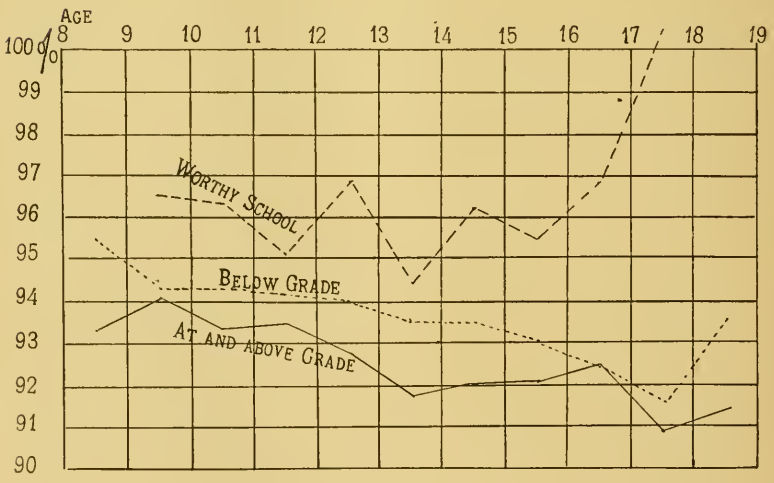
TABLE X. RIGHT-HANDEDNESS AND SCHOOL STANDING.

Age.		Number of Pupils Tested.	Right Hand Grip.	Left Hand Grip.	Per Cent. Left is of Right.
8	At and above grade	397	12.72	11.87	93.31
	Below grade	90	11.39	10.88	95.56
9	At and above grade	307	15.00	14.11	94.08
	Below grade	142	14.22	13.41	94.32
	John Worthy School	2	14.25	13.75	96.49
10	At and above grade	315	16.73	15.63	93.43
	Below grade	179	16.24	15.33	94.40
	John Worthy School	10	15.30	14.80	96.73
11	At and above grade	246	19.06	17.83	93.54
	Below grade	205	18.33	17.27	94.22
	John Worthy School	24	18.10	17.20	95.03
12	At and above grade	262	21.87	20.28	92.73
	Below grade	241	20.35	19.14	94.05
	John Worthy School	54	18.90	18.30	96.83
13	At and above grade	271	25.44	23.34	91.74
	Below grade	214	24.13	22.59	93.60
	John Worthy School	47	22.22	20.89	94.14
14	At and above grade	372	28.08	25.83	92.00
	Below grade	179	27.31	25.55	93.56
	John Worthy School	65	22.70	21.85	96.26
15	At and above grade	439	30.51	28 19	92.06
	Below grade	145	31.89	29.67	93.03
	John Worthy School	51	25.62	24.48	95.55
16	At and above grade	259	33.95	31.40	92.49
	Below grade	241	32.37	29.93	92.46
	John Worthy School	24	27.88	27.27	97.81
17	At and above grade	178	34.56	31.40	90.86
	Below grade	165	33.93	31.09	91.63
	John Worthy School	7	31.20	31.43	100.73
18	At grade	80	34.48	31.50	91.36
	Below grade	97	34.75	32 55	93.65

CHART XVII.

Right-handedness and School Standing. Per cent Which the Strength of the Left Hand is of the Strength of the Right for Pupils at and above Grade, Those below Grade, and the Boys of the John Worthy School.

Based on Data in Table X.



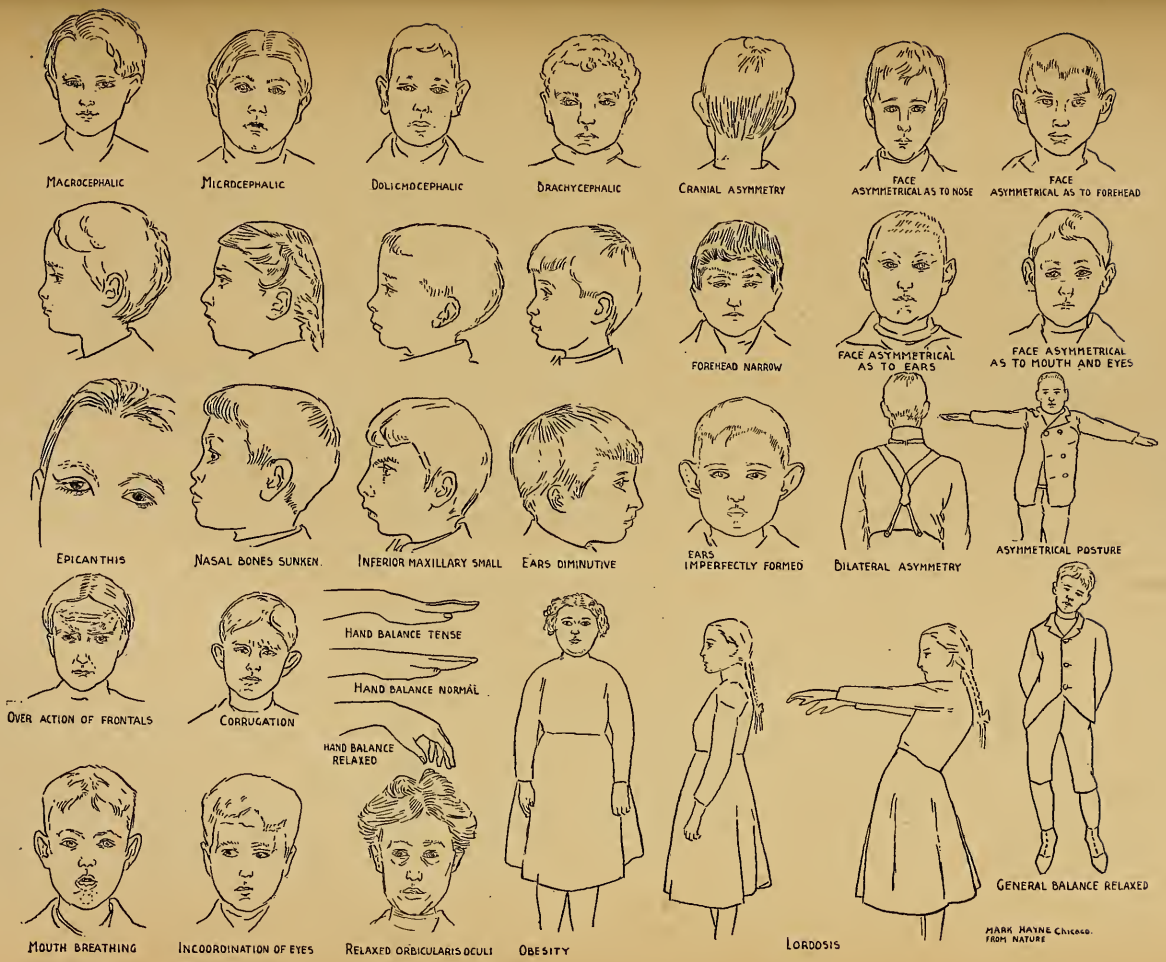

MACROCEPHALIC
MICROCEPHALIC
DOLICHOCEPHALIC
BRACHYCEPHALIC
CRANIAL ASYMMETRY
FACE ASYMMETRICAL AS TO NOSE
FACE ASYMMETRICAL AS TO FOREHEAD
FOREHEAD NARROW
FACE ASYMMETRICAL AS TO EARS
FACE ASYMMETRICAL AS TO MOUTH AND EYES
EPICANTHIS
NASAL BONES SUNKEN
INFERIOR MAXILLARY SMALL
EARS DIMINUTIVE
EARS IMPERFECTLY FORMED
BILATERAL ASYMMETRY
ASYMMETRICAL POSTURE
OVER ACTION OF FRONTALS
CORRUGATION
HAND BALANCE TENSE
HAND BALANCE NORMAL
HAND BALANCE RELAXED
MOUTH BREATHING
INCOORDINATION OF EYES
RELAXED ORBICULARIS OCULI
OBESITY
LORDOSIS
GENERAL BALANCE RELAXED
MARK HAYNE Chicago. FROM NATURE

FIG. 3

GROWTH ABNORMALITIES AND MOTOR DEFECTS.

On the back of each card was printed a list of abnormalities of growth and defective movements as follows:

Growth:

- Macrocephalic
- Microcephalic
- Dolichocephalic
- Brachycephalic
- Cranial asymmetry
- Face asymmetrical as to:
  - Forehead
  - Nose
  - Eyes
  - Ears
  - Mouth
- Forehead retreating
  - Narrow
- Palpebral fissures small
- Epicanthis
- Nasal bones sunken
- Superior maxillary small
- Inferior maxillary small
- Hare lip
- Palate cleft
  - Narrow
  - High
  - Asymmetrical
- Ears diminutive
  - Imperfectly formed
- Obesity
- Bilateral asymmetry
- Spinal curvature
- Deformed limbs
- Crippled

Movement:

- Quick
- Sluggish
- Restless
- Incoordinated
- General balance relaxed
- Asymmetrical posture
- Head balance asymmetrical
- Lordosis
- Over action of frontals
- Corrugation
- Blinking
- Incoordination of eyes
- Immobility of eyes
- Relaxed orbicularis oculi
- Hand balance asymmetrical
  - Tense
  - Relaxed
- Finger twitches
- Blushing
- Pallor
- Mouth breathing
- Defective speech

When the child came in the room to take the tests, an observer carefully inspected him and noted the growth and movement abnormalities. A slight abnormality was marked with one X, a more decided by two, a marked abnormality by three, and extreme by four. The results of this inspection are shown in Tables XI and XII, and in Charts XVIII and XIX.

It is found that the dull pupils have more of these cranial and facial asymmetries and other growth peculiarities than the bright children. From the study of movements of children, it is found that the dull children show more cases of imperfectly controlled movement than are found among the brighter children.

The John Worthy boys far exceed even the dull pupils of the other schools both in the average number of growth abnormalities and in the number of motor defects.

All this forces us to the conclusion that, with children, a high, symmetrical intellectual development is likely to be attained only when there is an approach to physical perfection.

TABLE XI. GROWTH ABNORMALITIES.

Age	8	9	10	11	12	13	14	15	16	17	18
Number examined	212	171	155	131	131	132	163	183	117	77	43
Average number of abnormalities seen in pupils at and above grade	4.6	4.6	4.9	5.1	4.0	3.7	4.1	3.9	3.7	3.7	3.1

CHART XVIII.

Average Number of Growth Abnormalities Seen in Pupils Who Are at and above Grade, Those below Grade, and Boys of the John Worthy School.

Based on Data in Table XI.

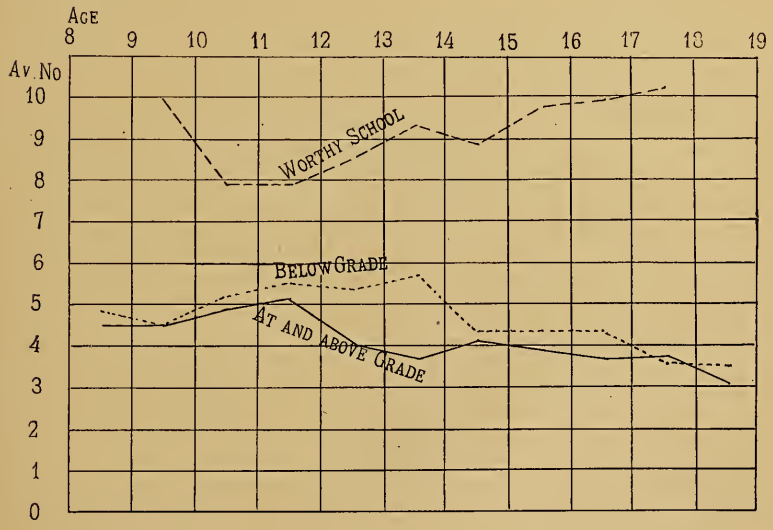
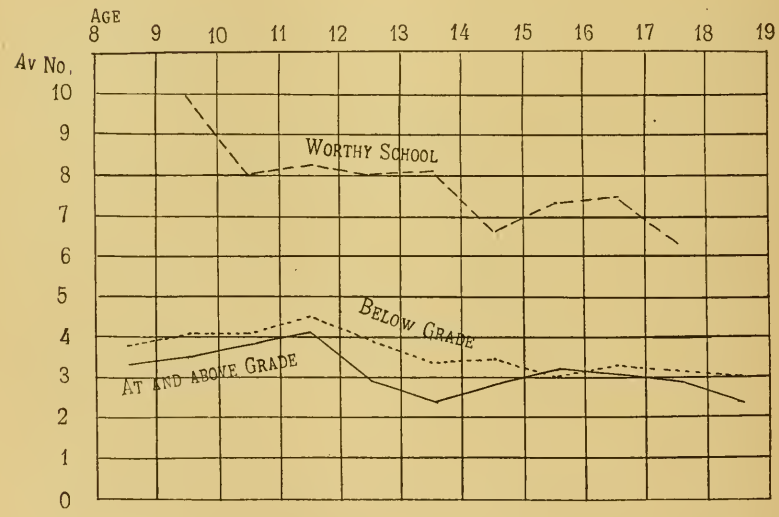


CHART XIX.

Average Number of Motor Defects Seen in Pupils at and above Grade, below Grade, and Boys of the John Worthy School.

Based on Data in Table XII.



Number examined.....	57	88	118	122	146	132	93	59	134	96	55
Average number of abnormalities seen in pupils below grade.....	4.9	4.6	5.1	5.5	5.3	5.7	4.3	4.3	4.3	3.6	3.5
Number examined.....	..	2	10	24	54	47	65	51	24	7	..
Average number of abnormalities seen in pupils of John Worthy School.....	..	10	7.9	7.9	8.6	9.3	8.9	9.7	9.9	10.3	..

TABLE XII. MOTOR DEFECTS.

Age.....	8	9	10	11	12	13	14	15	16	17	18
Number examined. 212		171	155	131	131	132	163	183	117	77	43
Average number of motor defects seen in pupils at and above grade.....	3.4	3.6	3.8	4.1	2.9	2.4	2.8	3.2	3.1	2.9	2.4
Number examined.....	57	88	118	122	146	132	93	59	134	96	55
Average number of motor defects seen in pupils below grade.....	3.8	4.1	4.1	4.6	3.9	3.3	3.5	3.0	3.3	3.2	3.0
Number examined.....	..	2	10	24	54	47	65	51	24	7	..
Average number of motor defects seen in pupils of John Worthy School.....	..	10.0	8.0	8.2	8.0	8.1	6.67	7.3	7.5	6.3	..

TESTS OF SIGHT.

The sight of the pupils was tested in the Kozminski, Andersen and Tennyson elementary schools and the Englewood and Lake View high schools. This test of visual acuity was made by means of the ordinary Snellen's type, the test cards being selected by Dr. Frank Allport, consulting oculist and aurist to the Department of Child-Study. Well lighted rooms were used for these tests. In testing sight the child was seated in a chair placed twenty feet away from the test chart, and, with the left eye covered, he was asked to begin at the top of the card and read aloud down the card as far as he could. After this was done the right eye was covered and the left eye tested. The last line of which the pupil was able to read the majority of the letters showed his visual acuity for the eye used. Visual acuity was recorded by placing the number representing the normal reading distance of the last line which the pupil was able to read as the denominator and the distance from which it was read (twenty feet) as the numerator of a fraction. Thus, if a child seated twenty feet from the chart could read the majority of the letters of the line normally read at thirty feet, but could not read a majority of the letters of the line normally read at twenty feet, he would be $\frac{20}{30}$ in visual acuity for the eye tested.

These tests were made without spectacles where the pupils wore glasses, as the aim was to find the number with subnormal visual acuity for each year.

Four thousand, seven hundred and sixty-five pupils were

tested — 2,030 boys, 2,735 girls. Thirty-five per cent of all the pupils tested were found defective — 37 per cent of the girls, and 32 per cent of the boys; thus 5 per cent more of the girls were found to be defective than the boys. Table XIII. and Chart XX. show something of the results of these tests. Thirty-two per cent of the six-year-old pupils were found subnormal in vision. For the first three years of school life the per cent of those defective rapidly increases, suggesting that the school work of that period is hard on the eyes of the pupils. After the age of nine years is passed the per cent of pupils having eye defects decreases; at first slowly, then more rapidly until the age of thirteen is passed. This decrease in the per cent of eye defects parallels so closely the period of rapid growth and development that the improvement may be considered a manifestation of the improved health of this period of florid growth. The slight rise at fourteen is probably due to the larger proportion of girls found in the high schools at that and the following years. It will be remembered that girls have a larger per cent of eye defects than boys.

The second curve in Chart XX. is obtained by disregarding the minor defects. It represents those who are $\frac{20}{40}$ or below in one or both eyes. The distance between the curve of $\frac{20}{30}$ and that of $\frac{20}{40}$ shows that considerably more than one-half of those counted as subnormal in visual acuity are only slightly so. Many of these slighter defects however, are known to be productive of immediate distress and of serious conseqences if neglected. This second curve follows the same general course as the first. It reaches its maximum a year later however and the improvement at the period of rapid growth is decidedly less. The latter part of the curve remaining so much higher than the beginning shows how few recover from these more decided defects. The third curve gives cases where the visual acuity is $\frac{20}{70}$ or less in one or both eyes. Starting at about one per cent at six years old the curve reaches its first climax between the tenth and eleventh years and shows only the slightest recovery, practically only cessation of increase, at the period of rapid growth. The lowest curve is hardly so interesting from a pedagogical standpoint as the others. It includes those having visual acuity of $\frac{20}{200}$ and below in one or both eyes. This is almost blindness and in many cases is due to accident. The curve rises steadily, as one would expect, because the chances of accident increase with age. The changes in the curves at seventeen are due probably to the paucity of numbers.

CHART XX.

School Life and Sight, Showing the Per Cent Defective in Visual Acuity for each Year.

Based on Data in Table XIII.

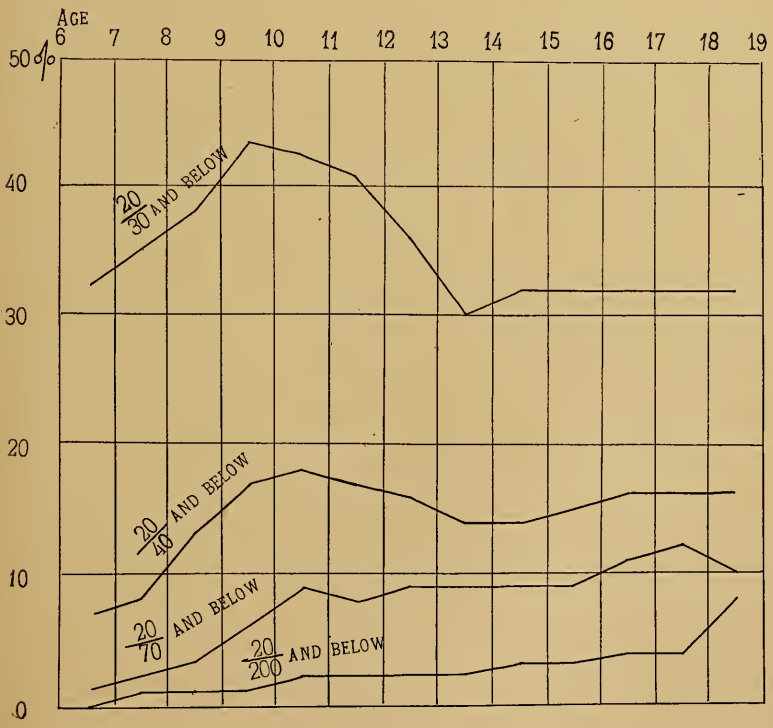


TABLE XIII. SCHOOL LIFE AND SIGHT.

AGE	No. Tested	20/30 and below.	20/40 and below.	20/50 and below.	20/70 and below.	20/200 and below.
6	264	32	7	4	1	0
7	363	35	8	4	2	1
8	351	38	13	9	3	1
9	343	44	17	11	6	1
10	364	43	18	13	9	2
11	385	41	17	13	8	2
12	364	36	16	14	9	2
13	373	30	14	13	9	2
14	450	32	14	13	9	3
15	521	32	15	13	9	3
16	475	32	16	13	11	4
17	339	32	16	14	12	4
18	173	32	16	13	10	8

DEFECTIVE VISION AND SCHOOL STANDING.

The influence of defective vision on school standing is shown in Table XIV and Chart XXI. It appears that on the average a smaller per cent of the pupils at and above grade have defective sight than those below grade. The fact that the reverse is true during the first two years led to an investigation which gave quite conclusive evidence that the increase in eye defects during the first years of school life is due, in part at least, to school conditions. It will be seen that eight and nine year old pupils who have made the best advancement have the greater per cent. of eye defects. On investigation it was found that the more advanced pupils in this case had on the whole started to school younger, and this longer time at school is believed to account for both the advanced standing and the increased number of those who are subnormal in visual acuity.

Forty-eight per cent of the boys of the John Worthy School were subnormal in visual acuity, while but twenty-eight per cent of the boys of the same average age tested in the other schools were thus defective.

Many of the John Worthy boys had strabismus, hypermetropia, and astigmatism, conditions which would induce asthenopia when the eyes were used in close and long application to books, and it is easy to believe that the strain thus set up when an attempt was made to study was a factor in producing dislike for school and subsequent truancy.

CHART XXI.

Defective Vision and School Standing.

Based on Data in Table XIV.

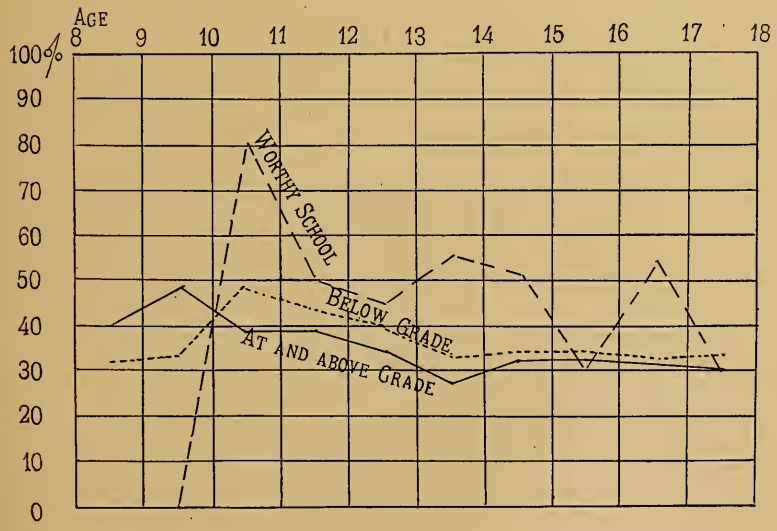


TABLE XIV. SCHOOL STANDING AND SIGHT.

AGE.	NUMBER TESTED.	PER CENT DEFECTIVE.
8	At and above grade	40
	Below grade	32
9	At and above grade	47
	Below grade	34
	John Worthy School	00
10	At and above grade	39
	Below grade	48
	John Worthy School	80
11	At and above grade	39
	Below grade	43
	John Worthy School	50
12	At and above grade	34
	Below grade	40
	John Worthy School	46
13	At and above grade	27
	Below grade	33
	John Worthy School	55
14	At and above grade	32
	Below grade	33
	John Worthy School	52
15	At and above grade	32
	Below grade	34
	John Worthy School	30
16	At and above grade	31
	Below grade	32
	John Worthy School	54
17	At grade	30
	Below grade	33
	John Worthy School	29

TESTS OF HEARING.

Hearing was tested by means of the audiometer invented by Professor C. E. Seashore, of the Iowa State University, and described fully by him in Studies in Psychology, Vol. II., issued from that University. This is a piece of electric apparatus so constructed that the operator can vary the current at will, producing clicks of different degrees of loudness in the telephone receiver held at the subject's ear. The intensities of the current, and hence intensities of the sound vibrations, are graded arbitrarily along the scale from one to forty. The threshold of hearing is determined by producing a click loud enough to be heard clearly by the subject and then passing gradually down the scale until the click becomes so slight that the subject cannot hear it. The figures on the scale at the point producing the slightest sound that can be heard is taken to represent the subjects acuteness of hearing. Because the click is made in direct contact with the ear of the subject external noises are less confusing than is the case with most tests of hearing; nevertheless these sounds do interfere somewhat, and on this account the quietest room in the building was always selected for these tests.

Table XVI. and Chart XXII. are based on tests on 5,706 pupils.

There seems to be no decided sex difference in the matter of hearing. The girls, on the whole, are found to have about one per cent. less of defective ears than the boys. Chart XXII. on Hearing Defects and School Life bears a striking resemblence to the corresponding one on sight, in that the number of defects increases during the first few years of school life and then the number gradually decreases. This correspondence suggests that, in part at least, the changes may be due to a common cause.

Chart XXIII. and Table XVI., in reference to Hearing and School Standing, show the decided disadvantage at which the child with poor hearing is placed. The pupils of the John Worthy School do not seem to differ strikingly in the number of cases of hearing defects from the pupils in the other schools.

The following table shows the per cent. of pupils who are defective in hearing by the number of points indicated:

TABLE XV.

	Three or More Points below Normal.	Four or More Points below Normal.	Five or More Points below Normal.
With one ear.	25.3 per cent.	16.8 per cent.	12.2 per cent.
With both ears.....	12.3 per cent.	6.8 per cent.	3.2 per cent.

From this table it appears that there are a large number of pupils whose two ears differ in hearing power. These will be at a decided disadvantage if seated on the wrong side of the room.

TABLE XVI. HEARING DEFECTS AND SCHOOL LIFE.

PUPILS WITH DULL HEARING.

Age	No. Tested.	Three or More Points below Normal.				Four or More Points below Normal.				Five or More Points below Normal.			
		In One Ear		In Both Ears		In One Ear		In Both Ears		In One Ear.		In Both Ears	
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
6	341	89	26	56	16	52	15	22	6	29	9	8	2
7	452	134	30	72	16	73	16	32	7	51	11	15	3
8	481	167	35	80	17	112	23	46	10	79	16	25	5
9	444	119	27	67	15	79	18	33	7	58	11	19	4
10	493	127	26	60	12	79	16	34	7	56	11	18	4
11	450	118	26	64	14	79	18	32	7	62	14	16	4
12	499	107	22	53	11	75	15	28	6	60	12	17	4
13	484	105	22	48	10	74	15	32	7	60	12	16	3
14	538	128	24	56	10	89	17	32	6	58	11	13	2
15	563	139	25	51	9	94	17	34	6	66	11	20	4
16	476	104	22	50	11	73	15	36	8	60	13	24	5
17	319	64	20	33	10	49	15	24	8	36	11	16	5
18	166	45	27	12	7	35	21	7	4	21	13	2	1
...	5706	1446	.....	702	.....	963	.....	392	.....	688	.....	209	.....

CHART XXII.

Hearing Defects and School Life.

Based on Data in Table XVI.

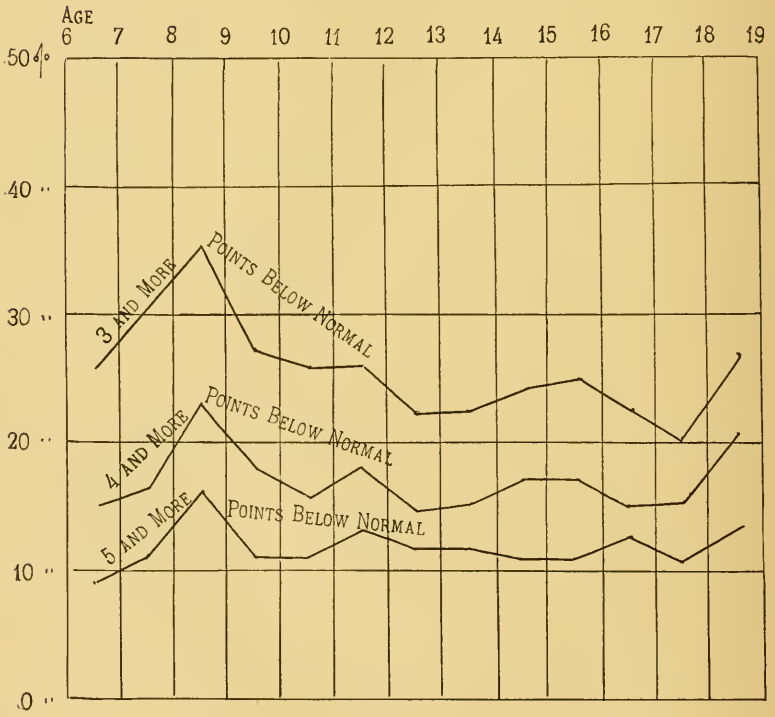


CHART XXIII.

Defective Hearing and School Standing.

Based on Data in Table XVII.

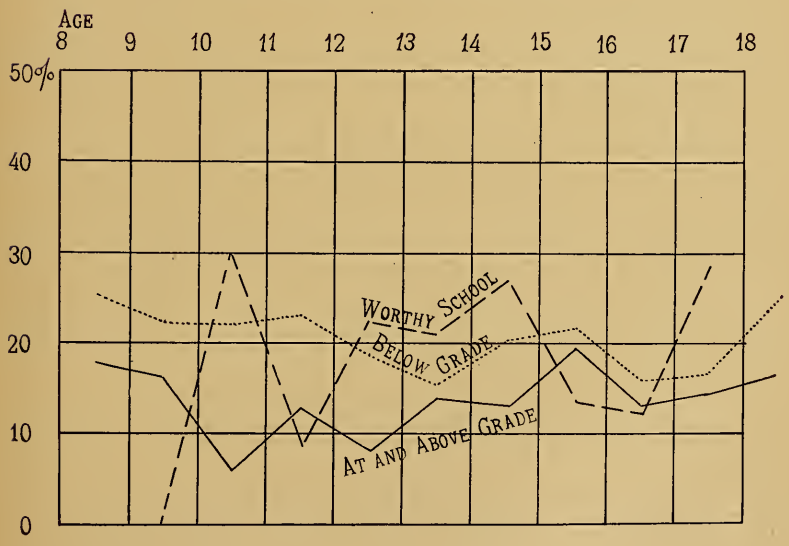


TABLE XVII. HEARING AND SCHOOL STANDING.

PUPILS HAVING ONE OR BOTH EARS DEFECTIVE TO FOUR POINTS BELOW NORMAL.

AGE.	NUMBER TESTED.	NUMBER DEFECTIVE.	PER CENT DEFECTIVE.
8	Above grade	138	25	18.1
	Below grade	85	22	25.8
9	Above grade	107	18	16.8
	Below grade	141	32	22.6
	John Worthy School	2	0	0.
10	Above grade	101	6	5.9
	Below grade	178	40	22.4
	John Worthy School	10	3	30.
11	Above grade	77	10	12.9
	Below grade	205	48	23.4
	John Worthy School	24	2	8.3
12	Above grade	118	10	8 4
	Below grade	242	45	18.5
	John Worthy School	54	12	22.2
13	Above grade	145	20	13.7
	Below grade	213	34	15.7
	John Worthy School	47	10	21.3
14	Above grade	248	32	12.9
	Below grade	176	36	20.4
	John Worthy School	65	18	27.7
15	Above grade	164	32	19.5
	Below grade	145	32	22.
	John Worthy School	51	7	13.7
16	Above grade	93	12	12.8
	Below grade	239	38	15.9
	John Worthy School	24	3	12.5
17	Above grade	61	9	14.7
	Below grade	162	27	16.6
	John Worthy School	7	2	28 6
18	At grade	75	13	16.
	Below grade	91	23	25.2

SPECIAL ERGOGRAPHIC WORK.

The ergograph gives two kinds of information concerning the individual tested. First, it shows the energy which the individual exerts in a given time under fixed conditions. This is expressed in centimeter kilograms and forms a basis for comparing the ergographic work of different individuals. Second, the ergographic tracing, or ergogram, made coincidently on the kymograph exhibits the manner in which the energy was exerted. Last year in the Alcott School the course of power during the school day (See Dr. Christopher's report) was worked out by testing eight pupils at different intervals during the day and determining the average amount of work done at each period. (See Table XVIII, Chart XXIV.)

CHART XXIV.

Course of Average Power throughout the School Day of Eight Pupils of the Alcott School.

Based on Data in Table XVIII.

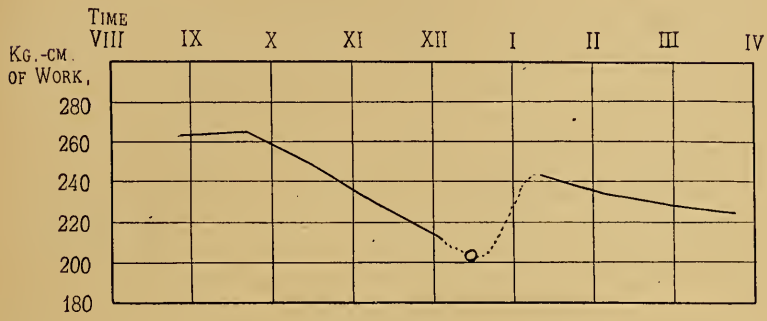


TABLE XVIII.

Data: Eight pupils (four boys and four girls) of the Alcott School were tested nine times during the school day. Each test consisted of ninety seconds' work. A weight of three kg. was lifted every other second.

Average time of test.....	8:51	9:37	10:32	11:20	12:07	1:23	2:08	3:00	3:45
Average work done.....	262	263	249	229	212	243	234	228	224

This experiment was repeated at the Tennyson School. During this process interesting data were unexpectedly obtained which go to show that the fatigue was due, in part at least, to the school work. Twelve pupils were being tested. In the case of four of them the results did not parallel the previous experience, these four showing unusual power near the close of the afternoon. Upon investigation it was found that the teacher of the four pupils had been called from school and that they had no regular work, but had been sent to another room and employed themselves, as they said, in having a good time. Charts XXV, XXVI and XXVI illustrate these facts.

CHART XXV.

Course of Average Power throughout the School Day of Twelve Pupils of the Tennyson School.

Based on Data in Table XIX.

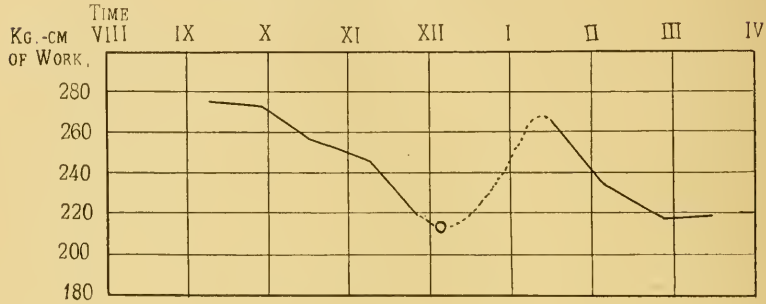


TABLE XIX.

Data: Twelve pupils (six boys and six girls) of the Tennyson School were tested nine times during the school day. Each test consisted of ninety seconds' work. A weight of three kg. was lifted every other second.

Average time of test.....	9:15	9:55	10:32	11:15	12:15	1:30	2:11	2:49	3:30
Average work done.....	276	273	258	246	220	267	235	218	219

CHART XXVI.

Course of Average Power throughout the School Day of Four Pupils Irregular in Their Work.

Based on Data in Table XX.

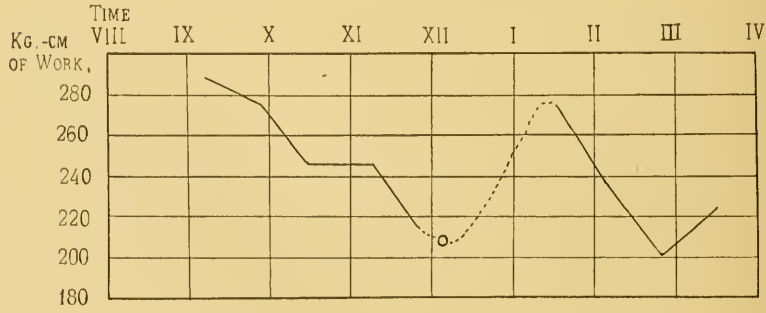


TABLE XX.

Data: Of the twelve pupils four worked irregularly, discontinuing their school work at 3 o'clock, with results as follows:

Average time of test.....	9:15	9:55	10:32	11:15	11:51	1:30	2:11	2:49	3:30
Average work done.....	289	275	248	245	215	275	237	201	224

CHART XXVII.

Course of Average Power throughout the School Day of Pupils Doing Regular Work.

Based on Data in Table XXI.

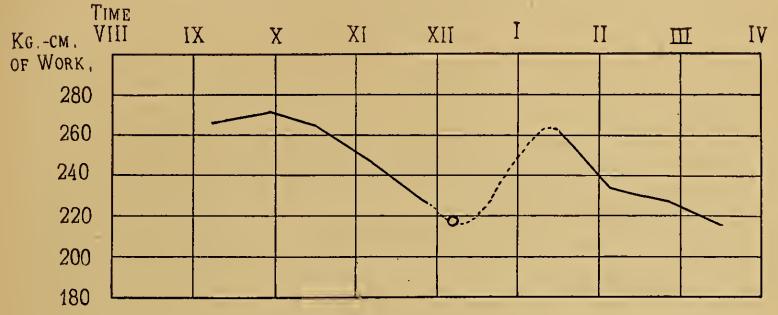


TABLE XXI.

Data: Of the twelve pupils eight worked regularly at their school work.

Average time of test.....	9:15	9:55	10:32	11:15	11:51	1:30	2:11	2:49	3:30
Average work done.....	266	271	265	245	227	262	234	228	216

While the child-study corps was at work at the Englewood High School, Principal Armstrong said that a complaint had been made by one of the patrons that certain written examinations were too exhausting, and asked to have ergographic tests made before and after an examination in geometry. This examination was unexpected by the pupils and so no opportunity was given for worry. The examination was intended to last for forty minutes, although a number of pupils finished it before the expiration of the allotted time. When asked to state whether the examination was difficult or easy, a few said that it was an easy examination, although Principal Armstrong and the majority of the class considered it to be rather hard. A comparison of the amount of ergographic work done before and after the examination showed that none of the pupils were seriously exhausted, and on the whole slighly more work was done after the examination than before it, which would seem to show that an examination of that length and given under those conditions is not exhausting.

A similar test in reference to a class exercise of forty minutes in the gymnasium gave a different result. The class made a much poorer record after than before the exercise in

physical culture, yet in this work it was the weaker and not the stronger pupils who were exhausted. To illustrate this the following ergograms of two girls are given. The first ergogram of T. R., Fig. 4, shows that she is strong and has her muscles in good control.

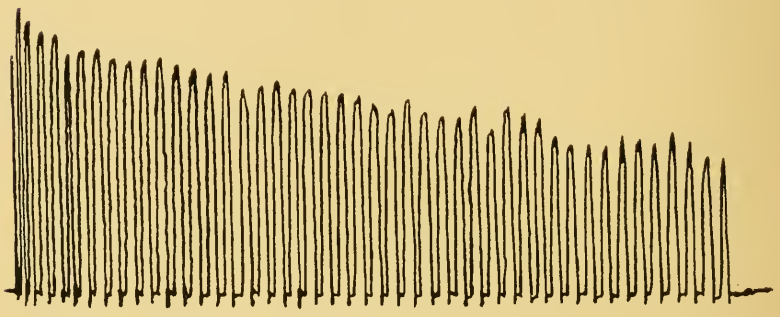


Fig. 4. Ergogram of T. R., a strong, healthy girl, before taking 40 minutes' work in the gymnasium. Weight used, 3.5 kg. Distance lifted, 151 cm. Work done, 528.5 kg.-cm.

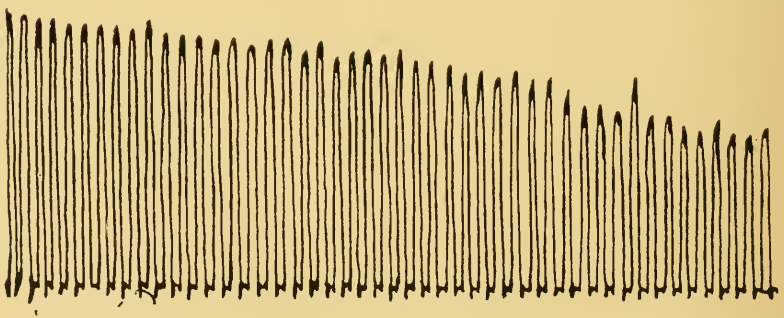


Fig. 5. Ergogram of T. R. after taking 40 minutes' exercise in the gymnasium, showing that the work was not exhausting. Weight used, 3.5 kg. Distance lifted, 149 cm. Work done, 521.5 kg.-cm.

The second ergogram taken after forty minutes of gymnasium work shows an amount of work almost identical with the first one; hence little energy has been lost through fatigue. The ergogram of a classmate, Fig. 6, shows her to be weak, and by the irregular output of energy somewhat nervous.

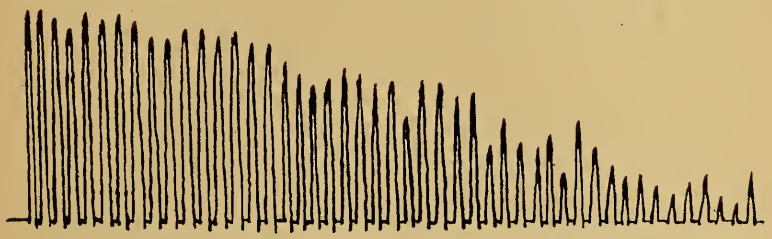


Fig. 6. Ergogram of C. E., a weak and somewhat nervous girl, before taking 40 minutes' work in the gymnasium. Weight used, 3.5 kg. Distance lifted, 89 cm. Work done, 311.5 kg.-cm.

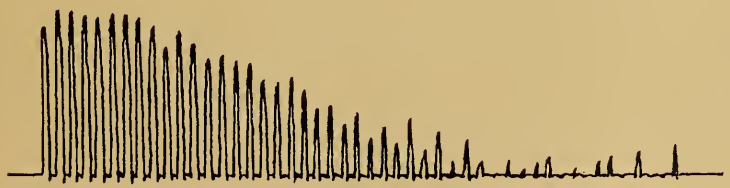


Fig. 7. Ergogram of C. E. after taking 40 minutes' work in the gymnasium, showing that the exercise proved very exhausting. Weight used, 3 5 kg. Distance lifted, 55 cm. Work done, 192.5 kg.-cm.

Her second ergogram, taken after forty minutes work in the gymnasium, shows her to be decidedly exhausted.

As was shown by the work of last year (See Dr. Christopher's report, page 25), there is a great difference in the endurance of individual pupils, and the class work may be too exhausting for some of the pupils without especially taxing the ability of others.

CONCLUSIONS.

Many of the tests and measurements which this department has made are preliminary to other investigations, which, it is suggested, should be carried on in reference to different lines of mental development, methods of instruction, and school adjustments. It is believed that the utility of much of the work so far done will best appear as it forms a basis for these future investigations and compilations; yet there are certain truths important for educational theory and practice which have been so clearly foreshadowed as to warrant their being set forth here.

From the investigations of last year Dr. Christopher formulated the following deductions:

1. In general there is a distinct relationship in children between physical condition and intellectual capacity, the latter varying directly as the former.

2. The endurance (ergographic work) of boys is greater than that of girls at all ages, and the difference seems to increase after the age of nine.

3. There are certain anthropometric indications which warrant a careful and thorough investigation into the subject of co-education in the upper grammar grades.

4. Physical condition should be made a factor in the grading of children for school work, and especially for the entrance into the first grade.

5. The great extremes in physical condition of pupils in the upper grammar grades, make it desirable to introduce great elasticity into the work of these grades.

6. The classes in Physical Culture should be graded on a physical instead of an intellectual basis.

The work this year, so far as it relates to them, confirmed these deductions, except as to the age, when great differentiation of the sexes in endurance begins. To these, certain other conclusions are added, not as settled beyond any possibility of modification, but yet as being fairly indicated by these tests.

1. The pubescent period is characterized by great and rapid changes in height, weight, strength of grip, vital capacity, and endurance. There seems to accompany this physical activity a corresponding intellectual and emotional activity. It therefore is a period when broad educational influences are most needed. From the pedagogic standpoint it is preeminently a time for character building.

2. The pubescent period is characterized by extensive range of all physical features of the individuals in it. Hence although a period fit for great activity of the mass of children, it is also one of numerous individual exceptions to this general

law. During this period a greater per cent of individuals than usual pass beyond the range of normal limits set by the mass. It is a time, therefore, when the weak fail and the able forge to the front, and hence calls for a higher degree than usual of individualization of educational work and influence.

3. Unidexterity is a normal condition. Rapid and marked accentuation of unidexterity is a pubescent change. On the whole, there is a direct relationship between the degree of unidexterity and the intellectual progress of the pupil. At any given age of school life, bright or advanced pupils tend toward accentuated unidexterity, and dull or backward pupils tend toward ambidexterity. The pupils of the John Worthy (Bridewell) School are more nearly ambidextrous than even the backward pupils of the ordinary schools. Training in ambidexterity is training contrary to a law of child life.

4. Boys of school age at the Bridewell are inferior in all physical measurements to boys in the ordinary schools, and this inferiority seems to increase with age.

5. Defects of sight and hearing are more numerous among the dull and backward pupils. These defects should be taken into consideration in the seating of pupils. Only by removing the defects can the best advancement of the pupils be secured.

6. The number of eye and ear defects increases during the first years of school life. The causes of this increase should be investigated and as far as possible removed.

7. There are certain parts of the school day when pupils, on the average, have a higher storage of energy than at other periods. These periods should be utilized for the highest forms of educational work.

8. The stature of boys is greater than that of girls up to the age of eleven, when the girls surpass the boys and remain greater in stature up to the age of fourteen. After fourteen, girls increase in stature very slowly, and very slightly, while boys continue to increase rapidly until eighteen.

9. The weight of the girl surpasses that of the boy about a year later than her stature surpasses his and she maintains her superiority in weight to a later period of time than she maintains her superiority in height.

10. In height sitting, girls surpass boys at the same age as in stature, viz., eleven years, but they maintain their superiority in this measurement for one year longer than they do in stature, which indicates that the more rapid growth of the boy at this age is in the lower extremities rather than in the trunk.

11. Commencing at the age of thirteen, strength of grip in boys shows a marked accentuation in its rate of increase, and this increase continues as far as our observations extend, viz.,

to the age of twenty. In girls no such great acceleration in muscular strength at puberty occurs, and after sixteen there is little increase in strength of grip The well known muscular differentiation of the sexes practically begins at thirteen.

12. As with strength of grip so with endurance as measured by the ergograph, boys surpass girls at all ages and this differentiation becomes very marked after the age of fourteen, after which age girls increase in strength and endurance but very slightly, while after fourteen boys acquire almost exactly half of the total power in these two features which they acquire in the first twenty years of life.

13. The development of vital capacity bears a striking resemblance to that of endurance, the curves representing the two being almost identical.

ACKNOWLEDGMENTS.

This investigation has not been the work of an individual, but of a department and I wish to commend my co-laborers, Charles C. Krauskopf, Daniel P. MacMillan, and C. Victor Campbell, for the able, painstaking, and devoted parts which they have taken in all of the work of the Child-Study Department; and I would extend to Miss A. Loesch most sincere thanks for the timely and efficient assistance which she freely gave to this work.

To you, gentlemen of the committee, I would make most grateful acknowledgement for the generous support and valued guidance which you have given to all the work of this department.

IMPORTANCE OF THE WORK.

Let me say in closing: More positive knowledge in any art or science means progress in that line. More definite knowledge of the growth and development of the child means educational progress. A very little addition to human knowledge here is a gain, not for Chicago alone, but for the world; not for the present alone, but for all the future, and that too right along the path of the advancement of civilization.

Respectfully submitted,

FRED W. SMEDLEY,

Director of Dept. of Child-Study and Pedagogic Investigation.

Chicago Public Schools

REPORT OF THE DEPARTMENT OF

CHILD-STUDY AND PEDAGOGIC INVESTIGATION

1900-1901

THE BLAKELY PRINTING CO CHICAGO 22

FRED WARREN SMEDLEY
Director

CHILD-STUDY REPORT NO. 3

CHICAGO PUBLIC SCHOOLS

REPORT OF THE DEPARTMENT OF

Child-Study AND Pedagogic Investigation

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CHILD-STUDY REPORT No. 3

CHICAGO:
THE BLAKELY PRINTING CO.
1902

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AUG 23 1910

A GROUP OF BOYS FROM AN ELEMENTARY SCHOOL.

The first boy on the right is in the first grade, the next two are fifth graders and the other three belong to the eighth grade. It will be noted that the first grade boy is taller than the shortest of the eighth graders.

Report of the Department of Child-Study and Pedagogic Investigation.

Edwin G. Cooley, Superintendent of the Chicago Public Schools.

Dear Sir:—The work of the Child-Study Department for the past year has included: (1) The determination of the size of the desk best suited to the pupils of the different grades and the proportion of adjustable desks required to accommodate the extreme cases; (2) the examination of children sent to the Child-Study Laboratory; (3) the supervision of the tests of sight and hearing of the pupils above the second grade in all the schools of the city; (4) the reëxamining and testing of the pupils of the John Worthy School; (5) assisting the board of physicians in charge of the physical examination of the candidates for admission to the Normal School, the cadets from the Normal School and the candidates for teachers in the public schools; (6) the carrying on of certain investigations in regard to child growth and development; (7) investigations in memory, with special reference to spelling.

SCHOOL DESKS.

At the beginning of the school year we were directed by the Committee on Child-Study and Pedagogical Investigation of the Board of Education to determine what sizes of desks are best suited to the pupils of each of the different grades and what proportion of the desks should be adjustable. It is well known that an ill-fitting desk impedes circulation, causes unhealthful postures, muscular strain, fatigue, and in time even spinal curvature. The discomfort engendered distracts the attention and interferes with the best conditions of school work. Some cities have met this problem by having all of the desks adjustable, but as adjustable desks are more expensive, and as it had been found

troublesome to adjust a large number of desks, the Chicago Board of Education adopted the policy of having only a portion of the desks adjustable. These measurements were undertaken to guide in the future purchase of desks. The measurements which we had previously taken of nearly seven thousand pupils were supplemented by special measurements, taken chiefly at the Alcott School. This gave us data for determining the matter upon a broad basis. The result of this investigation appears in the following report presented by Dr. W. S. Christopher, chairman of the committee, to the Board of Education, and adopted by them on September 19, 1900:

"The Committee on Child-Study and Pedagogical Investigation beg to report that at the opening of schools this fall it had observations made to determine the varying sizes of children which the several sizes of desks used can accommodate. Different children were placed in each desk until there was determined with reference to each desk the stature of the shortest pupil and the stature of the tallest pupil who could be properly accommodated by that desk.

"The results were as follows:

TABLE I.

Desk Number.	Height of Seat, Inches.	Maximum Stature Accommodated. mm.	Minimum Stature Accommodated, mm.
1	17	1865	1555
2	16	1740	1470
3	15	1620	1370
4	14	1500	1275
5	13	1382	1190
6	12	1270	1130

"The adjustable desks supplied under the existing contracts are known as:

"A1, with seat adjustable from 15½ in. to 17½ in.

"B1, with seat adjustable from 13½ in. to 15½ in.

"C1, with seat adjustable from 12 in. to 14 in.

"The measurements which have been made by this department since its inauguration supplied the material necessary to determine what percentage of pupils in each grade could be provided with a fixed desk, what size desk could accommodate the largest percentage of those pupils, and which adjustable desk and how many should be supplied.

"This information is given in the following table:

TABLE II.

Grade.	Desk Number.	Per Cent of Pupils of this Grade of Stature Below Minimum for this Desk.	Per Cent of Pupils of this Grade of Stature Within Limits Accommodated by this Desk.	Per Cent of Pupils of this Grade of Stature Above Maximum for this Desk.
H. S.	1	15.87	83.78	.35
8	2	10.75	86.56	2.69
7	3	4.18	78.07	17.75
6	3	11.06	83.53	5.41
5	4	3.07	81.55	15.36
4	4	8.75	87.04	4.21
3	5	3.50	82.91	13.59
2	5	19.97	77.50	2.53
1	6	25.77	72.42	1.80

"From information obtained from the business manager we find that at present the grades are supplied with desks as follows:

High Schools, No. 1.
Eighth Grade, No. 2.
Seventh Grade, No. 2.
Sixth Grade, No. 3.
Fifth Grade, No. 3.
Fourth Grade, No. 3.
Third Grade, No. 4.
Second Grade, No. 4.
First Grade, No. 5.
First Grade, No. 6.

"From which it would appear that grades 7, 5, 4, 3, 2 and part of the first are supplied with sizes too large to accommodate properly the largest percentage of pupils.

"It furthermore appears that in the first grade the smallest size desk now supplied, which is the same whether stationary or adjustable desks be considered, is too large for more than 25 per cent of the pupils.

"In view of the foregoing your committee respectfully recommends:

"1. That the several grades be supplied with stationary and adjustable desks in dimensions and percentages as follows:

TABLE III.

Grade.	Per Cent of Stationary Desks.	Dimensions.	Per Cent of Adjustable Desks.	Dimensions.
H. S.	85	1	15	A1
8	85	2	15	A1
7	75	3	25	B1
6	80	3	20	B1
5	80	4	20	B1
4	85	4	15	B1
3	80	5	20	C1
2	75	5	25	C1

"The committee further recommended that in view of the fact that 26 per cent of the pupils in the first grade are too small to be accommodated by any desk now purchased by the Board, the Committee on Buildings and Grounds be requested to secure bids for an adjustable desk whose seat shall be adjustable from 10 to 12 inches, and that when such desks are obtained the first grade rooms be supplied with 30 per cent of such adjustable desks and 70 per cent of desks No. 6."

THE CHILD-STUDY LABORATORY.

On most of the Saturdays during the school year the members of the Child-Study Department have had their time occupied in the examination of children brought to the laboratory by teachers and parents. Almost every wide-awake teacher meets with problems in the management of children in which more certain and definite knowledge of the child's condition will be of great assistance. At the Child-Study Laboratory trained observers of children, using instruments of precision, can often quickly point out wherein a given child differs from the ordinary child. When such a variation is injurious, some régime may be suggested which will tend to correct the defect. Many children are misunderstood. Parents often have a very wrong estimation of how their child compares with others. Many of the children were brought to the laboratory as a result of a difference of opinion between parents and teachers in regard to the child's ability.

While all principals have not made equal use of the laboratory, yet pupils from over sixty schools have sought its assistance. The three hundred children brought to the Child-Study Laboratory during the past year presented a large variety of problems. Many parents and teachers have brought children here to learn the nature and extent of their sensory defects. Very bright children have been brought to the laboratory to determine whether the phenomenal progress which they have been making is at the expense of their physical well-being. Principals have brought their own children to know how they compare with the average children of the same age, in order that these children whom they know best of all, may form a basis for their estimation of other children. Children who had failed to make progress in certain studies were presented to determine what the physical or

mental cause of their special deficiencies might be. Peculiar children were brought to determine whether the work of the kindergarten or of the primary school would best answer their needs. Children with very defective sight were examined and decision made as to whether the ordinary school or the department of the blind was best suited for them. Similar work was done with those with defective hearing. High school pupils, in order that they might choose their course of study wisely, have sought our opinion as to whether certain deformities would prevent their passing the physical examination for entering the Normal School. Teachers have brought pupils with speech defects to the laboratory in order to learn more about the nature and causes of the defects and how they best could be removed. Many dull, nervous and frail children have been brought in. Sometimes the child's needs demanded medical or surgical treatment, and he was referred to the family physician or a dispensary. Usually a hygienic and educational régime was most demanded. In passing upon some of the most difficult cases we have been greatly aided by the advice of Dr. Frank Allport, consulting oculist and aurist, and Dr. W. S. Christopher, consulting pediatrician to the department.

EXAMINATION OF SIGHT AND HEARING.

For the supervising of the tests of sight and hearing the following blanks were prepared under the direction of Dr. Frank Allport.

Dept. of C. S. & P. I. No. 2.

Room No.....
Teacher.....

School.....
Principal.....

CHICAGO PUBLIC SCHOOLS

Eye and Ear Examinations

Date.....190....

Entire number of pupils enrolled.... { Males..... / Females..... } Total.....

Average age.....

Number found defective and advised to consult family physician or an oculist or aurist ..... { Males..... / Females..... } Total.....

INSTRUCTIONS FOR EYE EXAMINATIONS.

First grade children need not be examined.

The examination should be made privately and singly in a room apart from the general school session.

Ascertain if the pupil habitually suffers from inflamed lids or eyes, or if the eyes grow tired, or if headaches commonly occur after study. Ascertain if the pupil is cross-eyed.

For the examination of the visual acuity, children already wearing glasses should be examined with them properly adjusted on the face.

Place a card of Snellen's test types on the wall in good light, the center of the card being about level with the pupil's eyes. This is NOT to be covered with glass. Do not expose the card except when in use, as familiarity with its face leads children to learn the letters by heart.

The line marked XX (20) should be seen at 20 feet; therefore, place the pupil 20 feet from the card.

Each eye should be examined separately.

Hold a card over one eye while the other is being examined. Do not press upon the covered eye, as the pressure might induce an incorrect examination.

Have the pupil begin at the top of the test card and read aloud down as far as he can, first with the right eye and then with the left.

If the pupil does not habitually suffer from inflamed lids or eyes, if the eyes be straight, and if he can read a MAJORITY of the XX (20) test types with each eye, and does not, upon inquiry, complain of habitually tired and painful eyes and headache after study, his eyes may be considered satisfactory, and his name should NOT be entered upon this sheet.

But if he habitually suffers from inflamed lids or eyes, if the eyes are not "straight," or he cannot read a MAJORITY of the XX (20) test types with each eye, or habitually complains of tired and painful eyes or headache after study, his name and detailed report of the examination should be entered on the back of this sheet by the examiner, and a card of information sent by the principal to the parent or guardian.

INSTRUCTIONS FOR EAR EXAMINATIONS.

In a room apart from the general school session examine the pupils singly, ascertaining if the pupil complains of earache in either ear, if matter (pus) or a foul odor proceeds from either ear, if the pupil fails to breathe freely through either nostril or if he breathe mostly through his mouth. Have the child turn his back and plug up the left ear with a cloth over his finger. The examiner steps away about 20 feet, asks the child a direct question in a low voice, requiring a direct answer. The right ear is then to be stopped and the left tested. If after several questions the child fails to hear the spoken words and answers incorrectly he is deemed defective. A good-sized watch is held about six feet away and gradually moved toward the ear to be tested, and distance at which the subject says he hears the tick is noted. It should be heard at least three feet away from the ear. If the pupil fails to hear spoken words or the tick of the watch as above noted, if he complains of earache, if pus or a foul odor is observed from either ear, if his nose is habitually stopped or if he is a mouth-breather, his name and a detailed report should be entered on the back of this sheet by the examiner and a card of information sent by the principal to the parent or guardian.

This report should be filled out and sent to Fred W. Smedley, Director of the Department of Child Study, by ———— A duplicate report, to which the teacher may refer from time to time, should be kept on file by the principal.

School_____ Room No._____ Grade_____

Examiner_____ Principal _____

CHICAGO PUBLIC SCHOOLS.

Eye and Ear Examinations.

NAME.	SEX.	AGE.	EYE.					EAR.					
			Does the pupil habitually suffer from inflamed lids or eyes?	State number of last line of test types which the pupil can read with Right Eye.	State number of last line of test types which the pupil can read with Left Eye.	Do the eyes and head habitually grow weary and painful after study?	Is the pupil probably "cross-eyed?"	Does the pupil complain of earache?	Does pus or foul odor proceed from either Ear?	Does the pupil fail to hear ordinary voice at 30 feet?	Does the pupil fail to hear tick of ordinary watch at 3 feet with either Ear?	Is the nose habitually stopped or the pupil a mouth-breather?	Did the pupil consult a physician and follow advice? If so, with what result?

It is believed that these directions are so simple and plain that they can be followed by any teacher with sufficient accuracy to determine whether sight and hearing defects exist with a given pupil. It is intended that these tests should be merely preliminary to those made by the physician, yet for the purpose of making this examination more efficient the Child-Study Laboratory was opened on Saturday afternoons for one month for the purpose of demonstrating to teachers how to make the tests. A number of the teachers availed themselves of this opportunity.

A pupil found to have sight or hearing defects was given the following warning card to hand to his parent:

CHICAGO PUBLIC SCHOOLS

CHICAGO, ILL.,.....190....

Dear Sir: *After due consideration, it is believed that your child has some* **Eye**.....**Ear*** *disease for which an* **Eye**.....**Ear*** *Doctor of recognized standing should be consulted. If you feel unable to consult one at his office, a Dispensary will do the work free of charge.*

It is earnestly requested that this matter be not neglected, as children with **Eye**.....**Ear*** *diseases cannot attain the best results in school.* *Respectfully,*

.....

Principal.....*School*

*Either the word "**Eye**" or "**Ear**" may here be crossed out, as may be appropriate for the case. If the pupil has presumably **Both** an **Eye and Ear** disease, both words may be left, and the space between the words "**Eye**" and "**Ear**" should be filled with the word "**and.**"

This card merely states that some eye or ear disease is believed to exist and that the consulting of a physician is advised. The matter is not compulsory, but the duty is thrown upon the parent, where it belongs.

While the reports sent into our department from the different schools are not all accurate enough to give compilations from them a scientific value, yet they bear witness to the fact that the work in many schools was done with great care and intelligence, and we have direct testimony that many children in our schools were helped by the parents taking steps to have the defects removed. While many parents proved neglectful, yet probably all of the pupils whom a teacher found defective were assisted through the augmented pedagogical skill which her increase in knowledge of their individual needs afforded her.

In our work last year (pp. 58-64 of the reprint) we demonstrated the disadvantage under which children having sight and hearing defects do their school work. So little is likely to be learned concerning the sight and hearing of pupils by the incidental attention of untrained observers, the tests are so easily made, the resulting knowledge may be so beneficial in securing the best welfare of the pupils, that it is believed that something in this line should be done at the beginning of each school year.

THE JOHN WORTHY SCHOOL.

In order to secure a broader basis for conclusions concerning the class of boys represented by the John Worthy School, the school in connection with the House of Correction, tests and measurements were again taken on the inmates, 317 in all. Seventy of these pupils had been measured last year, and the data from testing them were allowed to count again in the compilation here presented, which includes the work of both years. As seen from Table IV, the addition of these data from the examination of 247 new subjects, tends to confirm the conclusions of last year. The John Worthy boys are inferior in all the principal measurements taken, and this inferiority increases with age.

TABLE IV.

Comparison of the John Worthy Averages with the Norms.

NET HEIGHT.

Age.	No.	John Worthy Average, mm.	Normal, mm.	Per Cent John Worthy is of Normal.
9	6	1308	1289	101.47
10	25	1318	1330	99 09
11	51	1335	1370	97.44
12	99	1380	1418	97.32
13	114	1424	1488	95.79
14	144	1461	1546	94.50
15	111	1512	1613	93.73
16	37	1531	1665	91.96
17	14	1568	1690	92.78

HEIGHT SITTING.

9	6	699	699	100.00
10	25	712	713	99.86
11	51	717	729	98.34
12	99	740	747	99.06
13	114	754	777	97.04
14	144	768	806	95.28
15	111	784	837	93.67
16	37	795	871	91.27
17	14	819	891	91.91

TABLE IV—Continued.

WEIGHT.

Age.	No.	John Worthy Average, kg.	Normal, kg.	Per Cent John Worthy is of Normal.
9	6	28.825	27.616	104.37
10	25	31.148	29.837	104 39
11	51	32.422	32.519	99.70
12	99	34.459	35.626	96.72
13	114	37.394	40.276	92.84
14	144	39.083	44.786	87.26
15	111	44.065	50.994	86.41
16	37	44.751	55.219	81.04
17	14	46.025	59.343	77.55

GRIP.

Age.	No.	Right Hand.			Left Hand.		
		John Worthy, kg.	Normal, kg.	Per Cent, John Worthy is of Normal.	John Worthy, kg.	Normal, kg.	Per Cent, John Worthy is of Normal.
9	6	14.9	15.4	96.81	14.4	14.5	99.03
10	25	15.7	17.7	88.89	15.1	16.6	96.03
11	51	17.2	19.9	86.25	16.5	18.7	86.53
12	99	19.1	22.4	85.26	18.3	20.6	88.92
13	114	19.7	26.3	75.01	19.1	24.2	78.82
14	144	22.2	30.7	72.31	21.3	27.9	76.23
15	111	26.0	36.3	71.62	24.8	33.6	73.69
16	37	27.2	42.1	64.55	26.6	38.8	68.52
17	14	28.5	46.9	63.20	27.7	42.7	64.83

ERGOGRAPHIC WORK.

Age.	No.	John Worthy Average, kg.-cm.	Normal, kg.-cm.	Per Cent John Worthy is of Normal.
9	6	167.1	205.6	81.27
10	25	200.0	235.0	85.10
11	51	222.6	267.7	83.15
12	99	250.7	297.8	84.19
13	114	288.5	359.2	80.31
14	144	314.0	423.8	74.09
15	111	382.4	513.5	74.46
16	37	377.9	584.7	64.63
17	14	387.8	651.4	59.53

TABLE IV—Continued.

VITAL CAPACITY.

Age.	No.	John Worthy Average. cu. cm.	Normal, cu. cm.	Per Cent John Worthy is of Normal.
9	6	1566	1549	101.09
10	25	1657	1659	99.87
11	51	1669	1799	92.77
12	99	1763	1956	90.13
13	114	2000	2246	89.04
14	144	2239	2527	88.60
15	111	2413	2858	84.42
16	37	2488	3363	73.97
17	14	2660	3570	74.50

PERCENTILES.

The large addition to the numbers that have been measured and tested has permitted our classification of the results into percentile groups in reference to height, weight, strength of grip and vital capacity. Tables have thus been produced which will be of especial service in the Child-Study Laboratory and of value to all who make a study of individual children. By means of these tables one can determine closely how a given child compares with others of his age. These percentiles have been obtained in the following manner: The individual cards on which the measurements were recorded when the child was tested were arranged according to the size of the pupils in each measurement, grouped separately for each age in years. The minimum measurement in each such group gave the zero percentile for that group. To determine the ten percentile for that group, ten per cent of the number of cards was removed, beginning at the minimal end, and the highest measurement on the cards so removed was recorded as the desired ten percentile. Similarly the other percentiles were determined, the maximum measurement being recorded as the one hundred percentile.

The percentile charts, I to XII, are especially interesting as showing the comparative rate of growth and development at the different ages, and especially as showing the comparative growth of the large and small pupils. It will be seen that the pubescent age is the period of greatest extremes, that after that period many of the smaller pupils evidently gain somewhat on those of larger

and more precocious growth and development. The charts are especially valuable in locating a given child in the percentile group to which he belongs for any measurement. To do this the line of his age is followed across the chart, until a point representing his measurement is arrived at. The vertical lines on either side of this point limit the percentile group to which he belongs. Thus, a certain twelve-year-old boy is 149 cm. in height. Following the line of the twelve-year-old boys it is found that he is in the 80-90 percentile group in height. A comparison of the percentile groups to which he belongs in the different measurements will give his balance in growth and development. If this twelve-year-old boy, found in the 80-90 percentile group in height, be found in the 90-100 percentile group in height sitting, in the 90-100 percentile group in weight, in the 50-60 group in strength, in the 20-30 group in endurance, and in the 10-20 group in vital capacity, there is shown a decided lack of physical balance.

TABLE V.

PERCENTILES.—Four-year-old Boys. No. of Cases, 58.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.
100	1165	624	21.600	11	10 5	1050
90	1096	614	20.375	9	8.5	875
80	1063	610	18.775	8	7.5	800
70	1038	598	17.850	7.25	7	800
60	1029	593	17.275	7	6	750
50	1018	587	17.000	6	6	700
40	1010	583	16.600	5.5	5	700
30	997	578	16.250	5	4.5	650
20	986	568	15.875	4	4	600
10	964	554	14.550	3.5	3	600
0	866	502	12.900	3	2	500

PERCENTILES.—Five-year-old Boys. No. of Cases, 123.

100	1183	697	26.650	16	15.5	1250
90	1124	643	21.550	11	11	1075
80	1112	630	20.100	10	9.5	1000
70	1100	625	19.350	10	9	1000
60	1090	617	18.750	9.25	8.75	950
50	1079	612	18.475	9	8	900
40	1065	606	17.950	.8	7.5	900
30	1055	601	17.600	7	7	850
20	1045	595	17.075	6.5	6	800
10	1030	588	16.675	5	4.5	750
0	969	550	13.725	4	3	650

TABLE V—Continued.

PERCENTILES.—Six-year-old Boys. No. of Cases, 341.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1289	707	29.600	16.5	16.5	1600	193.5
90	1200	688	23.525	13.5	13	1325	149.8
80	1179	657	22.725	12	11.5	1225	134.9
70	1159	648	21.950	11.5	11	1200	124.5
60	1148	641	21.100	11	10.5	1125	114.8
50	1135	635	20.475	10.5	10	1100	105.0
40	1123	630	20.050	10	9.5	1075	99.2
30	1112	623	19.575	10	9	1000	85.4
20	1093	616	19.050	9	8	975	75.6
10	1067	603	18.275	8	7	900	63.0
0	988	568	15.875	5	4	700	32.4

PERCENTILES.—Seven-year-old Boys. No. of Cases, 432.

100	1360	732	32.025	20	20	1750	284.0
90	1248	689	25.600	15	14.5	1475	190.1
80	1225	679	24.500	14	13	1400	174.5
70	1212	670	23.800	13	12.5	1300	160.0
60	1200	664	23.000	12.5	12	1300	145.5
50	1190	658	22.450	12	11.5	1225	136.4
40	1172	652	21.900	11.5	11	1200	128.0
30	1163	644	21.200	11	10.5	1150	117.6
20	1146	638	20.650	10	10	1100	107.2
10	1125	626	19.850	9	9	1000	95.0
0	1036	587	17.000	5	5	700	46.5

PERCENTILES.—Eight-year-old Boys. No. of Cases, 428.

100	1382	756	62.200	24	22	2100	324.0
90	1320	710	28.800	18	17	1700	232.2
80	1278	700	27.100	16.5	15.5	1575	208.0
70	1262	690	26.025	15	14	1500	195.8
60	1245	683	25.300	14.5	13.5	1400	180.0
50	1230	676	24.300	13.5	13	1350	170.0
40	1216	670	23.900	13	12	1300	157.7
30	1201	662	23.175	12	11	1250	142.6
20	1185	653	22.350	11	10	1200	127.5
10	1161	642	21.450	10	9	1100	112.2
0	1097	607	17.900	7	7	800	46.8

TABLE V—Continued.

PERCENTILES.—Nine-year-old Boys. No. of Cases, 373.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1478	786	38.600	30	25	2250	391.0
90	1369	733	31.575	20	19	1850	287.3
80	1336	722	30.000	18	17.5	1700	250.0
70	1316	713	29.025	17	16	1625	234.0
60	1299	706	28.125	16.5	15	1600	219.3
50	1285	697	27.200	16	15	1500	205.2
40	1274	690	26.500	15	14	1450	187.5
30	1261	683	25.575	14	13	1400	174.0
20	1243	674	24.800	13	12	1300	160.0
10	1214	664	23.650	11.5	11	1225	140.6
0	1072	585	20.000	8	7	850	88.0

PERCENTILES.—Ten-year-old Boys. No. of Cases, 399.

100	1479	780	50.400	32	26.5	2750	525.0
90	1415	746	34.500	22	20	2000	326.5
80	1380	735	32.525	20	19	1900	292.0
70	1362	726	31.400	19	18	1800	275.0
60	1345	720	30.200	18	17	1700	254.1
50	1332	714	29.450	17	16	1650	241.3
40	1318	707	28.525	16.5	15	1600	224.0
30	1304	700	27.750	16	14.5	1500	208 0
20	1287	693	26.850	14.5	13	1450	189.2
10	1259	679	25.375	13	12	1350	169.1
0	1166	555	19.500	10	8	900	112.0

PERCENTILES.—Eleven-year-old Boys. No. of Cases, 356.

100	1639	819	52.400	31	26.5	3000	499.8
90	1452	767	37.865	25	23	2200	373.8
80	1425	755	35.650	23	21	2050	334.9
70	1403	748	34.300	21	20	1975	303.4
60	1389	739	33.285	20	19	1875	288.0
50	1378	730	32.162	19	18	1800	273.4
40	1357	723	31.200	18	17	1725	255.3
30	1342	714	30.075	17	16	1650	241.3
20	1324	706	28.855	16	15	1550	218.6
10	1291	692	27.675	15	13	1400	191.8
0	1131	632	18.850	11	10	1100	83.6

TABLE V—Continued.

PERCENTILES.—Twelve-year-old Boys. No. of Cases, 373.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1613	837	64.375	37	32	3150	588.8
90	1507	786	42.350	28	26	2400	427.8
80	1479	773	40.800	26	24	2225	380.8
70	1457	764	37.700	24	22	2100	353.4
60	1437	757	36.350	23	21	2025	327.8
50	1421	749	35.200	22	20	1950	306.8
40	1403	741	33.525	21	19	1875	290.0
30	1381	732	33.000	20	18	1800	266.0
20	1364	722	31.300	18	17	1700	234.0
10	1330	710	29.700	17	15	1600	206.4
0	1252	642	25.200	10	9	1150	106.2

PERCENTILES.—Thirteen-year-old Boys. No. of Cases, 353.

100	1730	944	72.700	62	50	4200	1086.3
90	1599	831	48.400	33	31	2750	502.4
80	1557	808	44.800	30	28	2500	450.0
70	1528	794	42.850	28	26	2350	406.1
60	1505	782	40.925	26	24	2300	378.0
50	1484	770	38.800	25	23	2200	353.7
40	1462	763	37.700	23	21	2100	331.2
30	1446	756	36.450	22	20	2000	312.5
20	1428	747	35.100	21	19	1900	285.2
10	1400	734	33.150	19	17.5	1800	243.0
0	1311	696	28.150	13	10	1500	136.5

PERCENTILES.—Fourteen-year-old Boys. No. of Cases, 359.

100	1763	950	68.325	56	51	4400	883.2
90	1666	868	55.300	40	36	3300	584.8
80	1614	845	51.150	35	32	2950	539.6
70	1592	826	47.975	32	30	2750	496.2
60	1569	813	45.900	30	28	2575	448.0
50	1550	802	44.125	28	26	2450	414.7
40	1523	790	42.050	26	25	2300	384.2
30	1492	778	40.150	24	23	2200	359.6
20	1468	765	37.900	22.5	21	2100	320.0
10	1435	750	35.200	21	19	1850	265.0
0	1305	700	25.900	15	14	1200	165.6

TABLE V—Continued.

PERCENTILES.—Fifteen-year-old Boys. No. of Cases, 262.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1846	958	97.925	63	61	4550	1049.6
90	1715	900	61.673	47	45	3650	735.5
80	1682	881	57.150	43	39	3400	643.7
70	1652	865	54.425	40	38.5	3200	591.5
60	1629	850	52.200	38	35	3000	546.0
50	1616	837	50.100	35	32	2800	516.8
40	1589	821	48.350	32	30	2700	458.7
30	1562	810	46.375	30	28	2500	416.8
20	1538	796	43.125	28	26	2350	374.0
10	1493	775	39.650	26	23	2150	315.9
0	1323	647	30.150	14	15	1400	152.0

PERCENTILES.—Sixteen-year-old Boys. No. of Cases, 174.

100	1853	957	105.625	85	79	5100	1317.2
90	1750	923	66.090	50	48	4200	777.7
80	1732	907	61.770	48	45	3800	697.6
70	1706	895	58.700	45	42	3600	640.2
60	1687	886	57.350	44	40	3500	593.6
50	1672	876	55.500	41	38	3300	543.6
40	1650	861	53.350	39	36	3150	511.0
30	1618	849	50.725	36	34	2950	481.2
20	1593	835	48.600	34	31	2800	444.0
10	1550	810	45.675	30	26	2400	415.4
0	1420	724	34.550	17	16	1800	264.0

PERCENTILES.—Seventeen-year-old Boys. No. of Cases, 106.

100	1828	963	81.400	72	67	5000	1117.8
90	1776	944	70.975	58	51.5	4350	825.6
80	1737	925	66.150	53	48	4000	774.4
70	1722	916	64.100	51.5	46	3850	717.6
60	1711	910	61.350	49	45	3700	675.1
50	1684	897	58.975	45.5	43	3575	646.0
40	1678	887	57.200	43.5	40	3450	608.0
30	1662	876	55.000	41	38	3250	562.4
20	1642	866	53 400	39	35	3125	525.6
10	1604	838	49.200	35.5	32	2900	447.2
0	1376	737	34.225	20	18	1750	337.8

TABLE V—Continued.

PERCENTILES.—Eighteen-year-old Boys. No. of Cases, 46.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1839	997	83.800	71	68	5000	1012.0
90	1814	955	71.360	62	58	4750	900.0
80	1784	937	67.340	58	52	4200	796.5
70	1764	932	65.600	54	49	4125	740.0
60	1748	929	64.875	51.5	48	3975	721.6
50	1742	926	63.825	49.5	46.5	3850	685.4
40	1720	914	62.360	48	45	3600	640.0
30	1695	902	60.100	46	41	3500	612.5
20	1677	886	56.440	44	39	3350	592.8
10	1659	865	53.800	41	35	3200	554.4
0	1610	830	45.575	36	31	2450	383.8

PERCENTILES.—Boys, Nineteen and Twenty Years. No. of Cases, 44.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.
100	1979	1010	98.000	77	62	5625
90	1831	964	74.874	64	60	4850
80	1786	947	70.230	61	53	4460
70	1758	924	68.360	60	52	4100
60	1739	920	66.560	57	50	3940
50	1728	910	63.300	51	48	3825
40	1708	903	59.990	50	46	3660
30	1697	888	57.425	47	42	3500
20	1652	884	54.740	46	40	3280
10	1637	858	53.775	42	38	3100
0	1481	814	47.625	37	32	2150

PERCENTILES.—Men, Twenty-one Years and Over. No. of Cases, 46.

100	1847	961	92.100	69	67	5500
90	1792	940	74.600	61	59	4840
80	1775	936	70.040	60	57	4480
70	1742	924	69.860	56	54	4320
60	1720	910	68.040	54	50	4150
50	1713	902	66.950	52	49	4100
40	1700	898	65.150	51	48	4000
30	1669	892	62.660	50	46	3900
20	1662	888	58.740	49	45	3700
10	1636	878	56.050	46	44	3300
0	1577	841	53.700	37	34	2950

TABLE V—Continued.

PERCENTILES.—Four-year-old Girls. No. of Cases, 58.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.
100	1161	650	21.975	9.5	9	875
90	1059	610	19.100	9	8	850
80	1043	600	18.150	7.5	7	825
70	1030	592	16.850	7	6.5	800
60	1020	585	16.575	6.5	6	800
50	1008	577	16.300	6	5.25	800
40	994	574	16.000	5.25	5	700
30	984	571	15.700	5	5	670
20	974	568	15.125	4	4	650
10	955	554	14.600	4	3	635
0	926	543	12.800	2.5	2	600

PERCENTILES.—Five-year-old Girls. No. of Cases, 116.

100	1184	662	23.600	13	11.5	1150
90	1137	631	20.600	10	9.5	975
80	1115	624	19.800	9	8.5	950
70	1091	616	18.975	8.5	8	900
60	1080	610	18.400	8	7	900
50	1067	602	17.850	7.5	7	850
40	1055	597	17.150	7	6.5	800
30	1042	591	16.625	6.5	6	800
20	1022	584	16.000	6	5	775
10	1001	572	15.200	5	4	700
0	937	533	13.300	3	2	600

PERCENTILES.—Six-year-old Girls. No. of Cases, 338.

Per cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1282	699	29.250	15.5	15	1400	208.0
90	1191	664	23.050	12	11	1275	140.0
80	1168	654	21.950	11	10	1175	123.2
70	1152	644	21.325	10	10	1100	112.5
60	1136	635	20.500	10	9	1050	103.6
50	1125	629	19.900	9.5	9	1000	95.2
40	1114	623	19.450	9	8	950	87.0
30	1101	617	18.850	8.5	8	900	80.6
20	1088	610	18.225	8	7	850	72.8
10	1065	597	17.200	7	6.5	800	60.0
0	959	556	13.850	4	4	600	39.6

TABLE V—Continued.

PERCENTILES.—Seven-year-old Girls. No. of Cases, 423.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1341	719	31.800	16	16	1650	289.8
90	1241	682	25.250	14	13	1300	166.4
80	1220	673	23.900	12.5	12	1250	147.2
70	1202	665	23.000	12	11	1200	136.5
60	1190	659	22.375	11	10.5	1150	123.2
50	1180	653	21.675	11	10	1100	114.0
40	1170	646	21.025	10	9.5	1050	106.5
30	1152	639	20.425	10	9	1000	98.8
20	1134	632	19.800	9	8	975	91.2
10	1113	620	18.550	8	7.5	900	79.3
0	975	585	15.350	5	4	750	42.0

PERCENTILES.—Eight-year-old Girls. No. of Cases, 401.

100	1408	757	41.175	20	19	1800	287.0
90	1300	704	27.700	15	14	1450	197.6
80	1274	693	26.150	14	13	1350	174.8
70	1257	685	25.300	13	12	1300	166.6
60	1245	678	24.400	12.5	11.5	1250	153.9
50	1233	673	23.800	12	11	1200	142.8
40	1221	667	23.050	11	10	1150	134.3
30	1205	660	22.400	10.5	9.5	1100	119.0
20	1188	653	21.550	10	9	1000	107.2
10	1165	642	20.700	9	8	950	95.4
0	1052	603	17.175	6	5	500	45.0

PERCENTILES.—Nine-year-old Girls. No. of Cases, 334.

100	1436	798	41.550	24	22.5	2100	437.8
90	1356	729	31.040	17	16	1600	236.9
80	1323	715	29.105	15.5	14.5	1500	212.5
70	1311	706	28.120	15	14	1450	195.8
60	1296	700	27.135	14	13	1400	180.5
50	1283	692	26.340	13	12.5	1325	171.0
40	1270	686	25.580	13	12	1300	158.5
30	1252	680	24.600	12	11	1200	146.3
20	1235	670	23.790	11	10	1200	134.3
10	1209	659	22.710	10	9	1100	118.5
0	1073	613	19.150	7	6	800	59.5

TABLE V—Continued.

PERCENTILES.—Ten-year-old Girls. No. of Cases, 369.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1577	806	58.225	32	31	2150	607.6
90	1411	750	34.700	19.5	18	1775	272.5
80	1382	735	32.150	17	16	1650	246.5
70	1359	724	31.200	16	15	1550	220.5
60	1342	717	29.750	15.5	14.5	1500	204.7
50	1326	710	28.665	15	14	1450	187.5
40	1307	703	27.775	14	13	1400	173.4
30	1295	695	26.550	13	12	1325	160.0
20	1279	690	25.550	12	11	1300	149.6
10	1248	673	24.000	11	10	1200	132.0
0	1157	630	19.300	8	6	800	40.8

PERCENTILES.—Eleven-year-old Girls. No. of Cases, 341.

100	1576	855	55.600	27	25	2400	487.2
90	1487	784	38.825	21.5	21	1950	323.6
80	1443	763	36.290	20	19	1800	294.8
70	1420	753	34.566	19	18	1700	263.5
60	1405	745	32.560	18	17	1650	240.0
50	1388	737	31.300	17	15.5	1600	222.0
40	1367	730	30.350	16	15	1500	210.0
30	1349	718	29.287	15	14	1450	189.1
20	1329	709	28.300	14	13	1400	173.9
10	1297	695	26.625	12	11	1300	154.5
0	1172	646	21.000	8	8	1000	79.2

PERCENTILES.—Twelve-year-old Girls. No. of Cases, 388.

100	1654	866	79.000	34.5	33.5	2950	651.7
90	1549	814	45.150	25	24	2200	372.6
80	1514	800	41.925	23	22	2025	332.2
70	1492	787	40.000	21	20	1950	294.0
60	1474	777	38.050	20	19	1825	269.7
50	1450	765	36.300	19	17.5	1750	255.3
40	1431	757	34.750	18	17	1675	232.5
30	1413	746	32.775	17	15	1600	217.8
20	1388	735	31.200	16	14.5	1500	195.2
10	1361	715	29.500	14.75	13	1400	168.0
0	1216	662	21.450	10	7	800	79.6

TABLE V—Continued.

PERCENTILES.—Thirteen-year-old Girls. No. of Cases, 387.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1718	912	78.000	45	40	3050	714.1
90	1602	849	51.500	30	27.5	2400	454.4
80	1578	832	47.650	27	25	2250	401.2
70	1558	824	45.000	25	24	2125	355.2
60	1540	812	42.950	23.5	22	2000	321.3
50	1519	798	41.000	22	21	1925	295.8
40	1498	788	39.200	21	20	1850	269.1
30	1479	777	37.200	20	18	1775	249.6
20	1448	764	35.500	18.5	17	1650	227.5
10	1413	746	32.800	17	15	1525	189.8
0	1300	683	24.400	10	9	1100	80.5

PERCENTILES.—Fourteen-year-old Girls. No. of Cases, 425.

100	1714	915	74.125	38	39.5	3200	759.6
90	1640	870	55.600	32	30	2600	489.8
80	1617	856	52.000	30	27.5	2400	438.1
70	1596	845	49.735	28	26	2300	400.0
60	1581	837	48.125	27	25	2200	372.4
50	1565	832	46.300	25	23	2100	342.8
40	1551	823	44 800	24	22	2000	324.0
30	1530	814	43.050	22	21	1927	291.6
20	1508	800	40.700	21	19	1800	271.6
10	1481	779	37.675	19	18	1700	217.9
0	1250	681	29.225	14	12	1350	56.4

PERCENTILES.—Fifteen-year-old Girls. No. of Cases, 448.

100	1737	919	81.350	47	47	3400	690.3
90	1645	876	57.400	33	31	2650	488.0
80	1620	865	53.800	31	29.5	2500	435.2
70	1605	856	52.075	30	28	2400	404.6
60	1590	847	50.150	29	27	2300	381.1
50	1574	840	48.700	28	25	2225	354.0
40	1561	831	47.300	26.5	24	2150	330.6
30	1547	823	45.500	25	22	2050	309.0
20	1529	814	43.300	23	21	1950	276.0
10	1506	801	41.250	21	20	1800	234.0
0	1391	660	30.975	12	10	1450	104.4

TABLE V—Continued.

PERCENTILES.—Sixteen-year-old Girls. No. of Cases, 427.

Per Cent.	Height, Standing, mm.	Height, Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg	Vital Capacity, cu. cm.	Work on Ergograph, kg. cm.
100	1785	946	91.775	48	47	3500	796.0
90	1663	889	60.415	35	33	2725	542.1
80	1636	876	56.540	33	31	2600	467.4
70	1622	866	54.525	31	29	2500	428.7
60	1604	859	52.790	30	28	2400	400.6
50	1593	850	51.150	29	27	2300	374.6
40	1580	845	49.375	28	26	2200	344.1
30	1560	837	47.630	26.75	25	2100	316.2
20	1546	827	46.160	25	23	2000	287.2
10	1516	813	43.685	23	21.5	1900	233.8
0	1365	643	33.900	18	15	1350	61.2

PERCENTILES.—Seventeen-year-old Girls. No. of Cases, 413.

100	1790	945	75.600	45	42	3500	649.8
90	1668	890	59.735	37	33.25	2825	520.3
80	1644	879	56.600	34	31.5	2600	459.0
70	1624	871	54.410	32.5	30	2500	418.0
60	1610	860	52.390	31	29	2425	397.2
50	1598	852	50.960	30	27.5	2350	377.4
40	1582	844	49.460	29	26	2250	338.2
30	1568	837	48.365	27.5	25	2150	310.0
20	1549	830	46.460	25.5	23	2050	268.0
10	1523	821	44.100	24	21.5	1900	229.6
0	1438	777	34.200	14	12.5	1250	156.0

PERCENTILES.—Eighteen-year-old Girls. No. of Cases, 343.

100	1771	937	82.150	48	47	3675	678.3
90	1676	892	59.800	38	34	2900	508.6
80	1649	876	57.075	35	32	2700	464.8
70	1628	869	55.200	34	31	2600	432.2
60	1612	864	53.480	32	30	2500	401.3
50	1600	856	52.050	31	29	2425	378.0
40	1589	849	50.660	30	27.5	2400	356.9
30	1572	842	49.400	29	26	2300	329.6
20	1554	833	48.100	27	25	2150	292.1
10	1527	825	46.100	25	23	2025	242.1
0	1385	743	35.075	17	16	1550	81.6

TABLE V—Continued.

PERCENTILES.—Nineteen-year-old Girls. No. of Cases, 241.

Per Cent.	Height Standing, mm.	Height Sitting, mm.	Weight, kg.	Grip of R. Hand, kg.	Grip of L. Hand, kg.	Vital Capacity, cu. cm.
100	1731	940	88.650	52	48.5	3700
90	1681	891	61.392	39	36	3000
80	1652	877	57.730	37	34	2800
70	1635	869	55.785	35	32	2700
60	1617	859	54.150	34	31	2600
50	1597	853	52.137	32	30	2500
40	1585	848	50.655	31	28	2400
30	1568	839	49.400	30	27	2300
20	1545	831	47.200	29	26	2200
10	1519	820	45.050	26.5	24	2025
0	1418	758	33.800	20	20	1700

PERCENTILES.—Twenty-year-old Girls. No. of Cases, 175.

100	1778	953	76.850	44	46	3600
90	1674	895	62.025	38	37	2900
80	1650	882	58.000	36	34	2800
70	1628	872	56.000	35	32	2700
60	1621	865	54.500	34	31	2600
50	1609	858	53.000	33	30	2550
40	1597	851	50.900	32	30	2500
30	1585	845	49.300	31	28	2400
20	1562	838	47.600	30	27	2300
10	1540	822	45.812	28	25	2250
0	1328	697	30.000	18	19	1300

PERCENTILES.—Female Teachers, Twenty-one Years and Over. No. of Cases, 223.

100	1787	931	101.100	47	42	3550
90	1677	892	63.000	39	36	3100
80	1655	882	58.720	37	35	2900
70	1635	876	56.855	35	33	2775
60	1625	868	54.775	34	31	2700
50	1607	861	53.688	33	30	2600
40	1592	854	51.860	32	29	2500
30	1576	847	49.980	31	28	2400
20	1560	834	48.380	30	27	2350
10	1530	823	46.400	28	25	2200
0	1474	797	39.000	22	20	1650

CHART I.

Percentiles of Net Height.

Boys.

Based on Data in Table V.

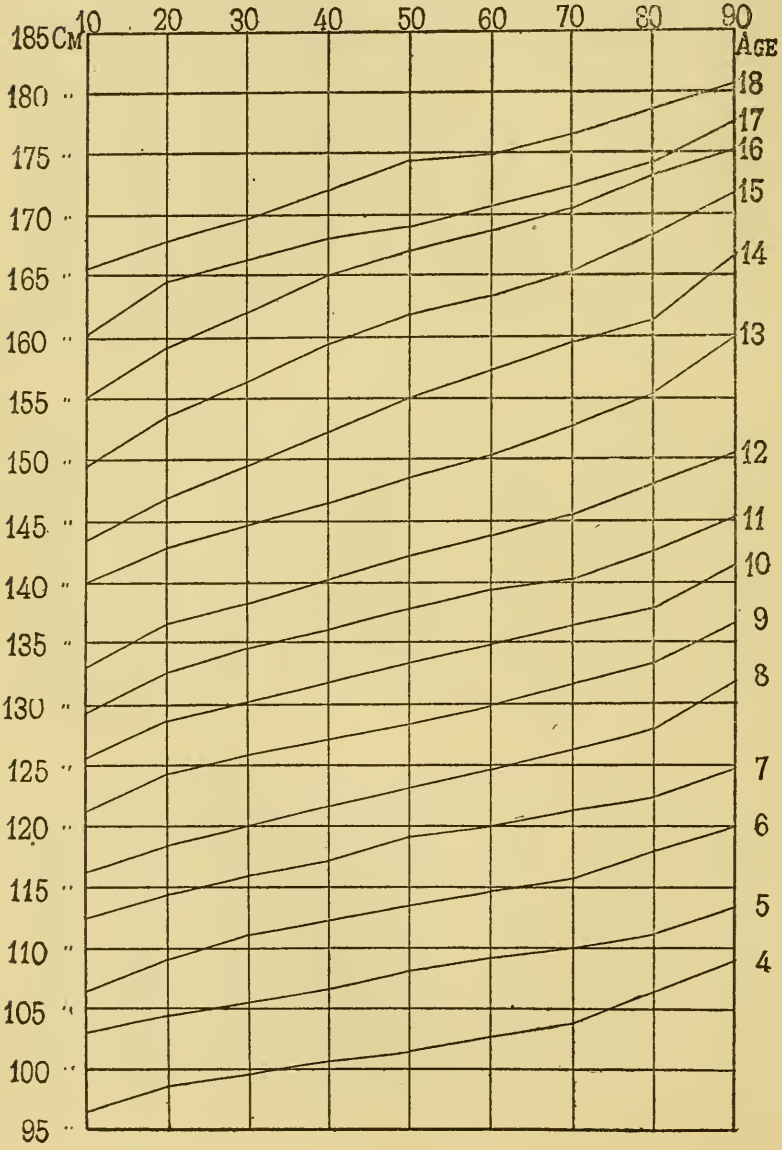


CHART II.

Percentiles of Height Sitting.

Boys.

Based on Data in Table V.

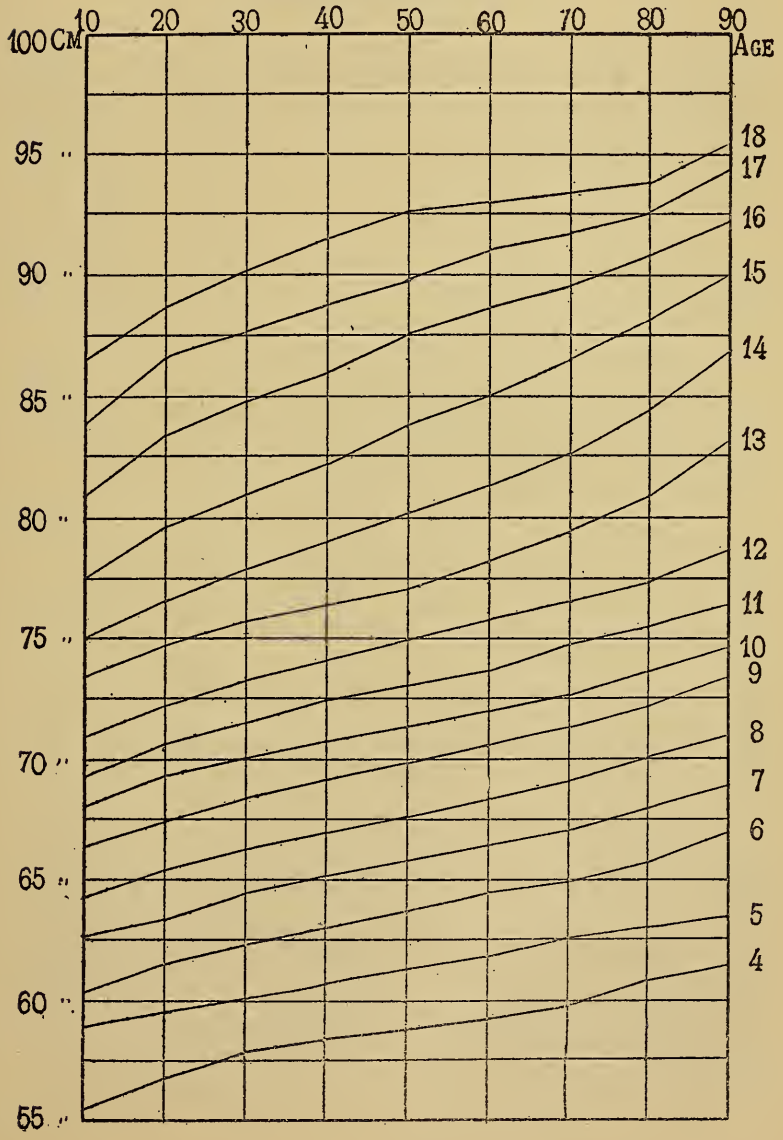


CHART III.

Percentiles of Weight.

Boys.

Based on Data in Table V.

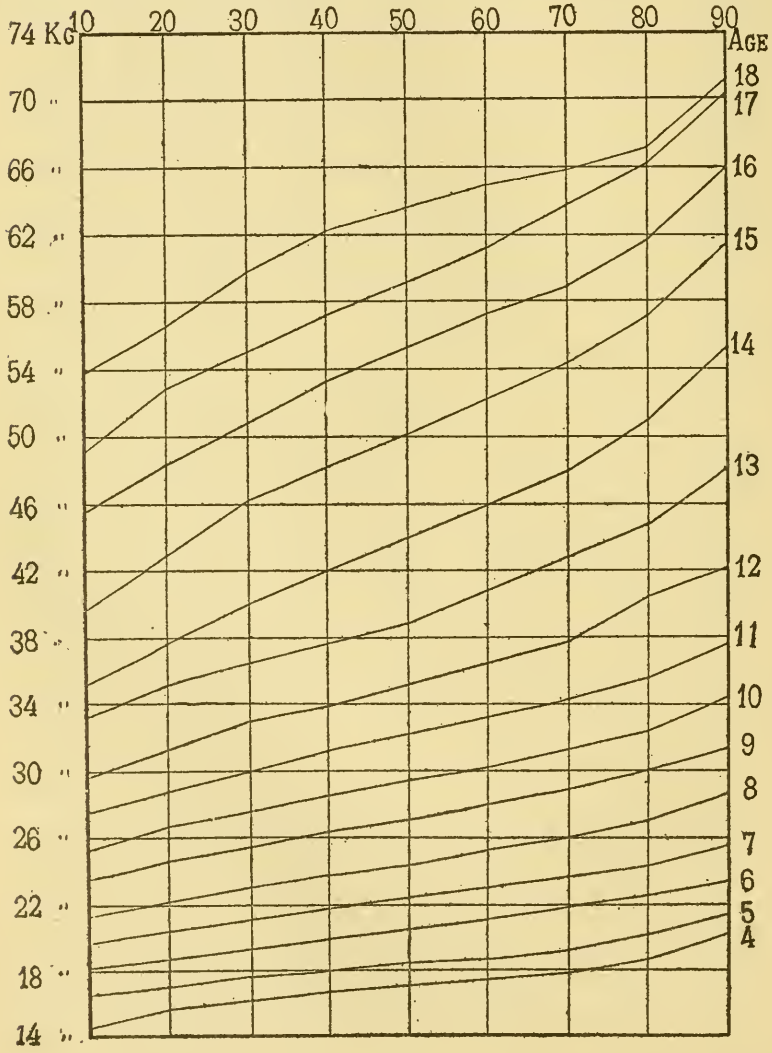


CHART IV.

Percentiles of Grip of Right Hand.

Boys.

Based on Data in Table V.

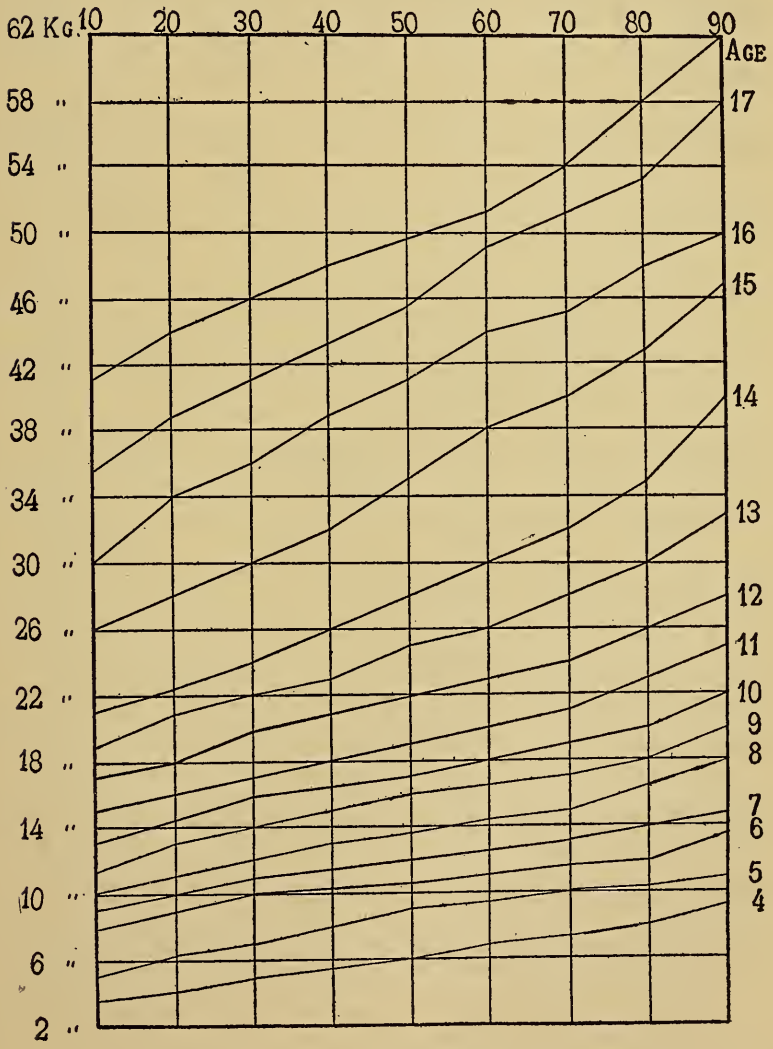


CHART V.

Percentiles of Vital Capacity.

Boys.

Based on Data in Table V.

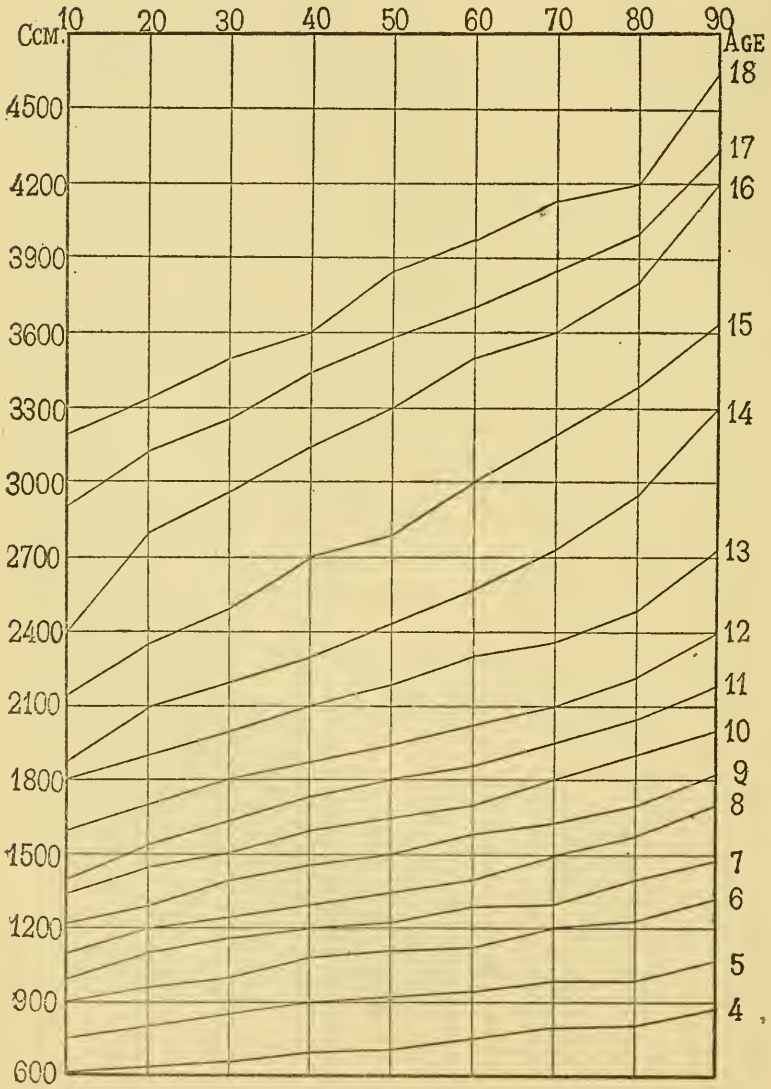


CHART VI.

Percentiles of Ergographic Work.

Boys.

Based on Data in Table V.

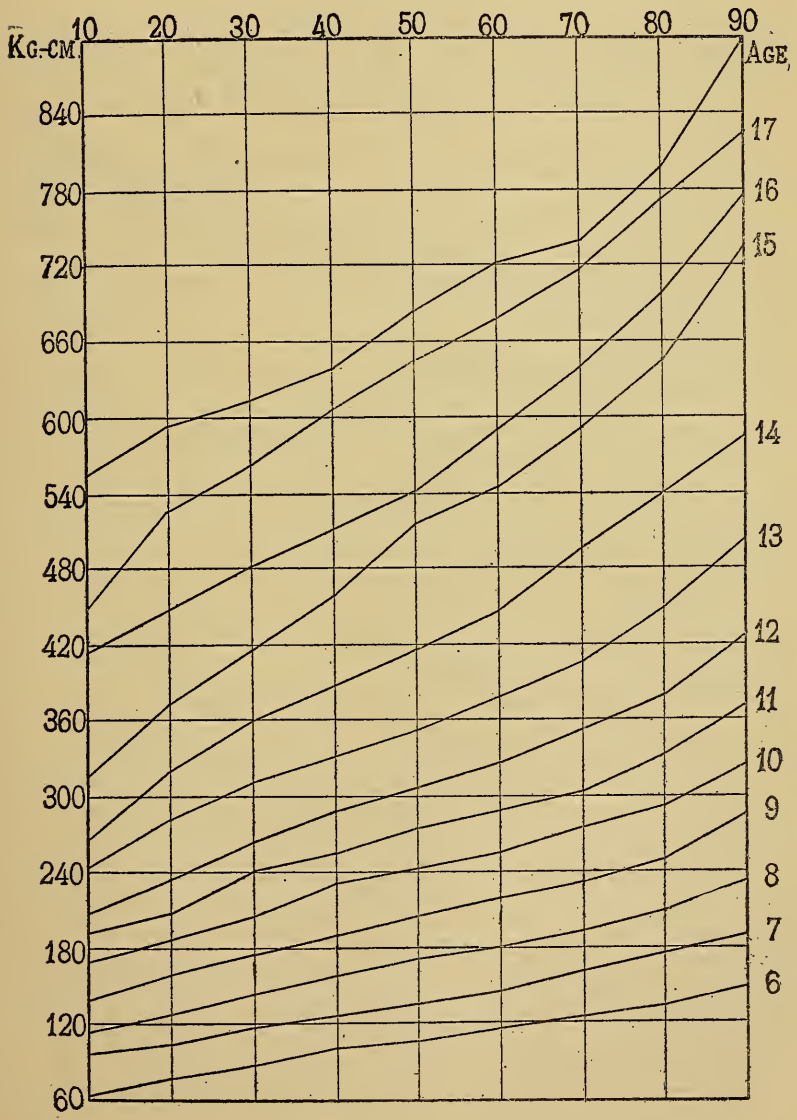


CHART VII.

Percentiles of Net Height.

Girls.

Based on Data in Table V.

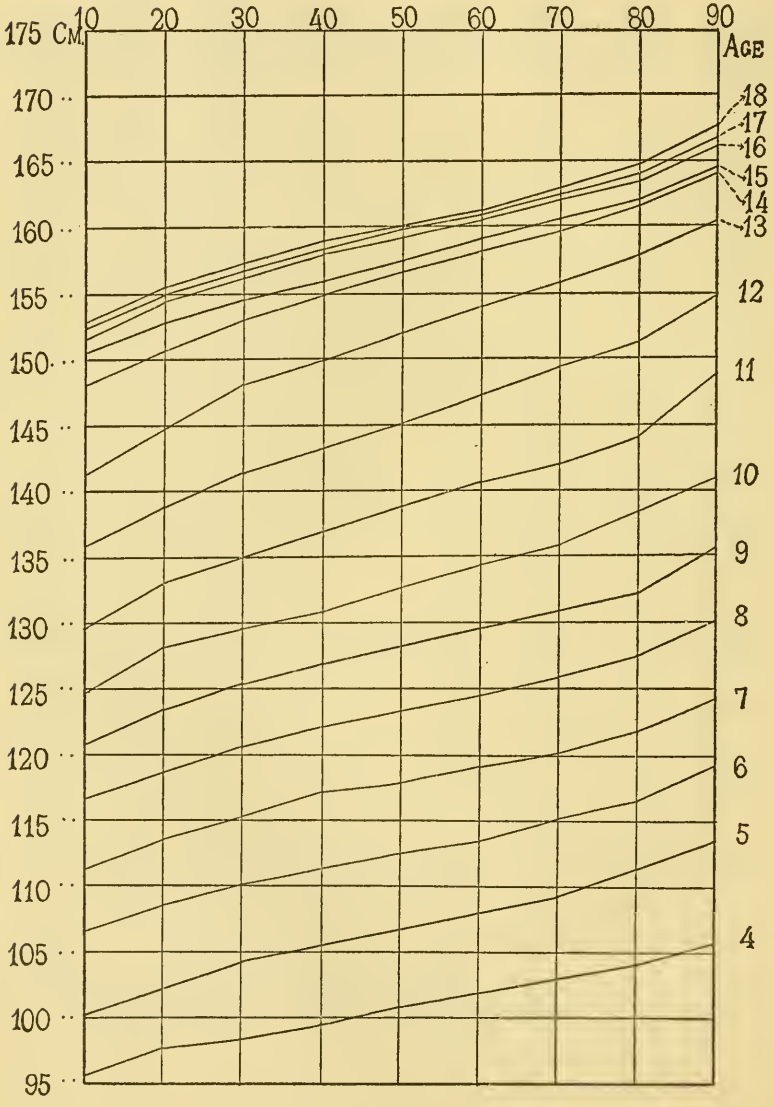


CHART VIII.

Percentiles of Height Sitting.

Girls.

Based on Data in Table V.

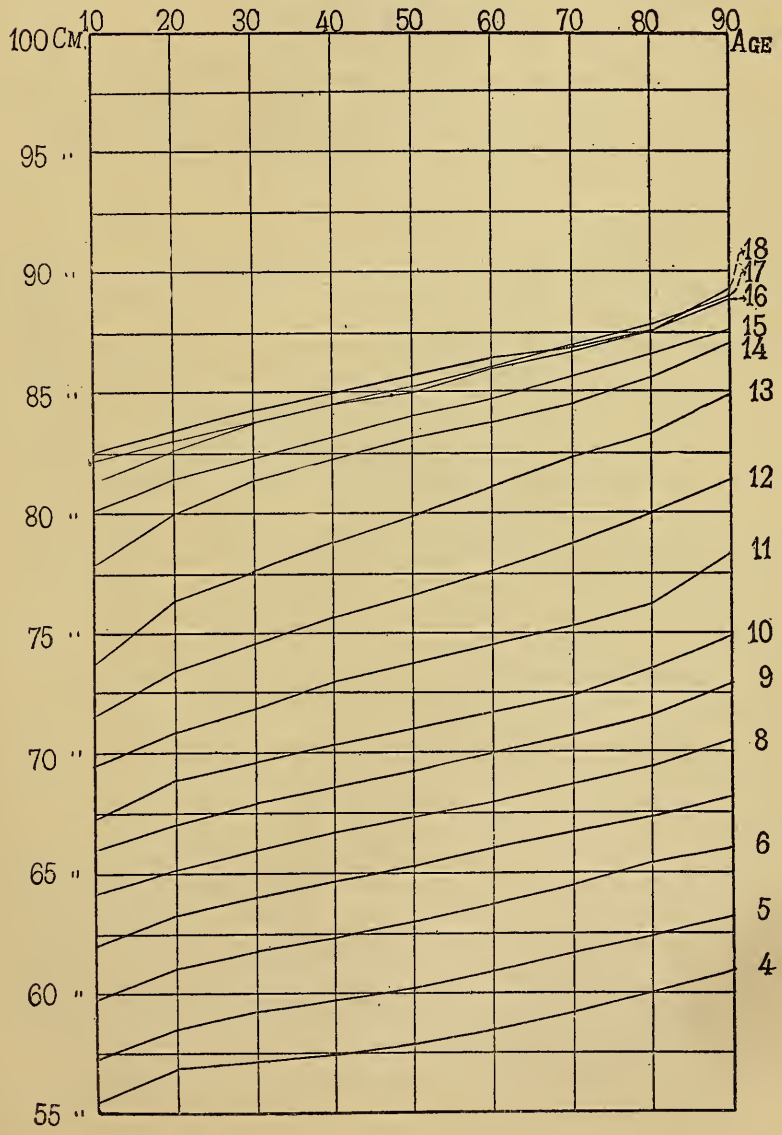


CHART IX.

Percentiles of Weight.

Girls.

Based on Data in Table V.

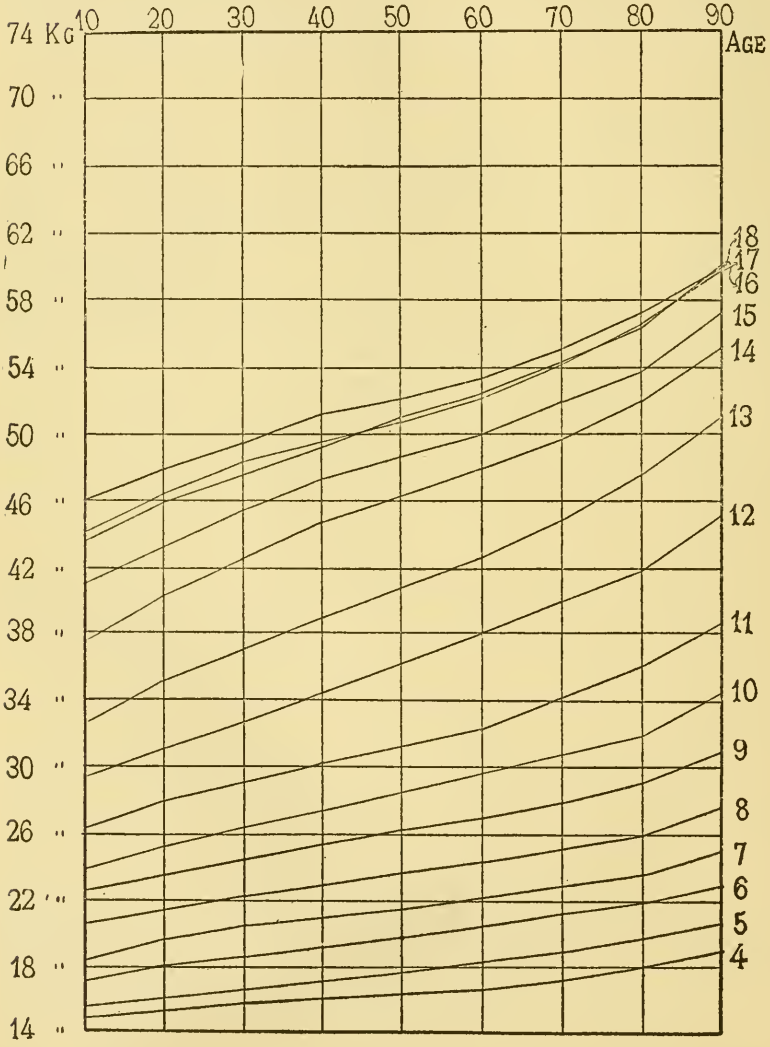


CHART X.

Percentiles of Grip of Right Hand.

Girls.

Based on Data in Table V.

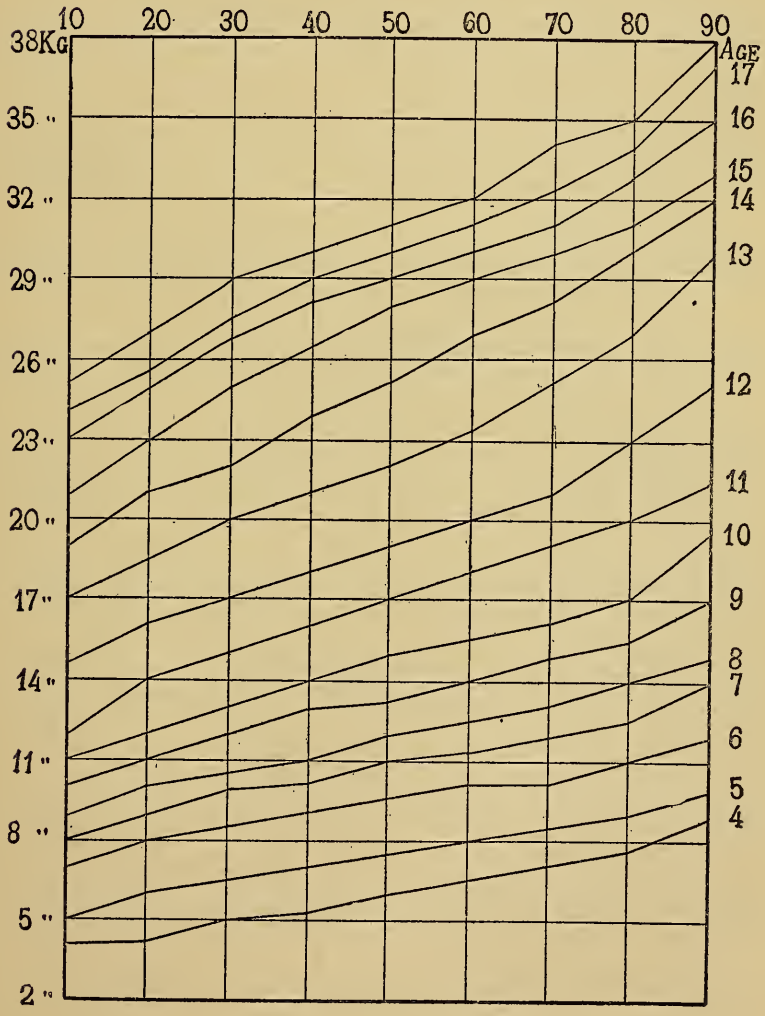


CHART XI.

Percentiles of Vital Capacity.

Girls.

Based on Data in Table V.

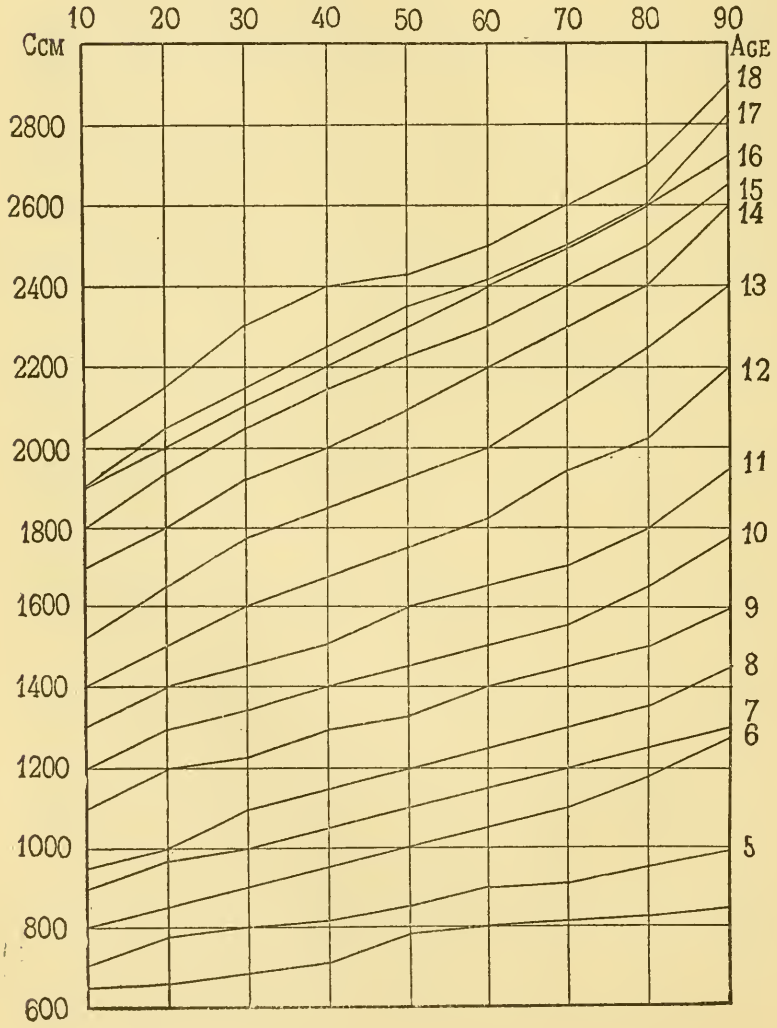
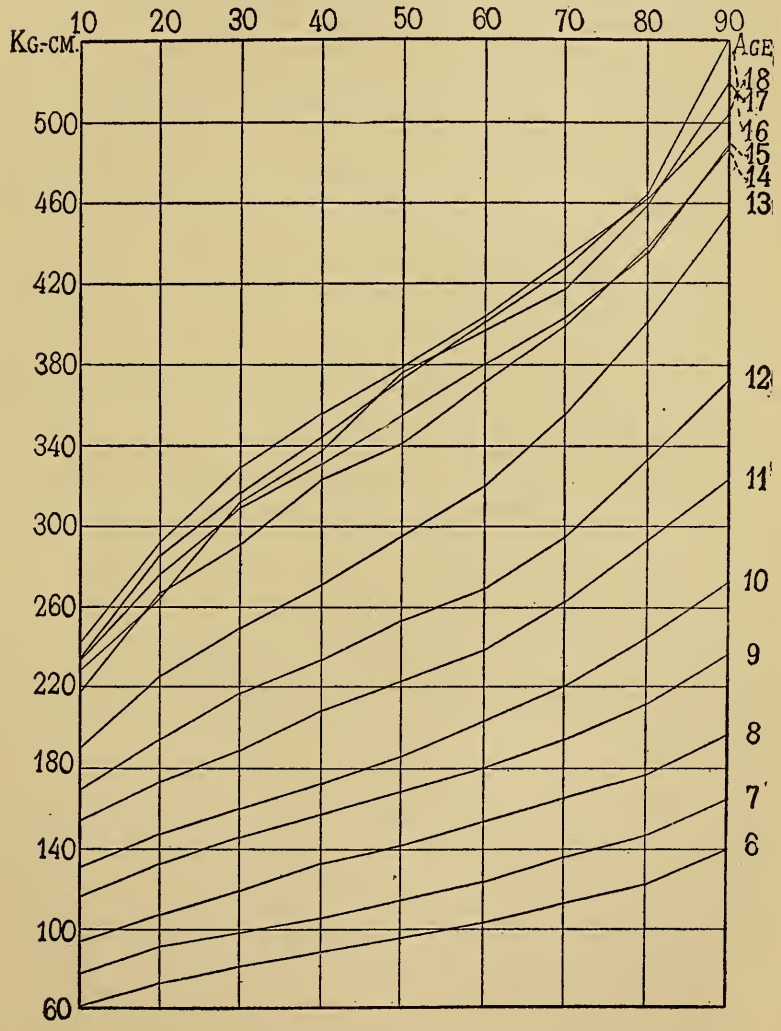


CHART XII.

Percentiles of Ergographic Work.

Girls.

Based on Data in Table V.



SCHOOL STANDING OF THE DIFFERENT PERCENTILE GROUPS.

The child is a very complex being. Many factors contribute to the development of his school efficiency. Often only by considering a factor in reference to a large number of children can it be determined whether it is favorable or unfavorable to a child's school advancement. In the report of last year we were enabled to say (p. 12) that the evolutionary ideal child stood somewhere above the average in each measurement, and later (pp. 35-46) to demonstrate that the more advanced pupils stood higher in the physical measurements than the backward ones. By taking the average number of school grades made by the several percentile groups of a given age we are enabled to compare the school efficiency of these groups. In order to present this matter on a broad basis, and to reduce it to a form sufficiently condensed as to show at once the relation of school standing to physical condition abstractly, and dissociated from age and sex, we have proceeded as follows:

1. The cards representing the individual pupils from eight to sixteen inclusive (irrespective of sex) were first classified into the several ages by years.

2. The cards were then arranged separately for each year of age, with reference to stature, and each year's group divided into its ten percentile groups. Then the average grades of all the pupils in each of these percentile groups were determined. Then the average grades of all the pupils in each of the same percentiles of each age were added together, and this sum divided by nine, the number of ages considered, to determine the average number of grades made by each of the several percentile stature groups. The results thus obtained are given in the first column of Table VI.

3. The same process was repeated for each of the several measurements taken, and the results so obtained are given in the several columns of Table VI under their appropriate headings. In this way it is thought that the relationship of physical condition to mental capacity, as shown by school standing, has been shown completely divested of the influence of age and sex. The total number of pupils involved in this compilation is 5,768.

This compilation in reference to stature has been graphically represented in Chart XIII. It will be seen from this chart that

the 90-100 per cent group has made on the average one more school grade, or a year's work, than has the 0-10 per cent group. If we take the average number of grades made by the very tallest pupils, the 100 percentiles, and compare this with the average made by the very shortest pupils, -0 percentiles, for each age, we will find that the tallest have made on the average 6.44 grades, while the shortest have made 4.50 grades.

Table VI shows that this greater school efficiency of those physically superior holds good also for height sitting, weight, strength, endurance and vital capacity, although not to the same degree in each. Part of this gain might possibly be explained on the supposition that those physically superior may have had better health and so have lost less time from school on account of illness than have the smaller and weaker ones; and so in part this higher standing of the larger pupils might be due purely to their physical superiority and not to their superior mental ability. On such a basis it might be easy to explain why certain smaller pupils are below grade, but such an explanation would hardly be so plausible in accounting for the fact that so many of the best physical specimens are above grade. Actual tests of the memory power show that the larger and stronger pupils are superior in native force of memory to the smaller and weaker. The true explanation will probably be found in the fact that those conditions which bring about large growth are favorable to the perfect formation and ideal balance of the brain and vital organs.

TABLE VI.

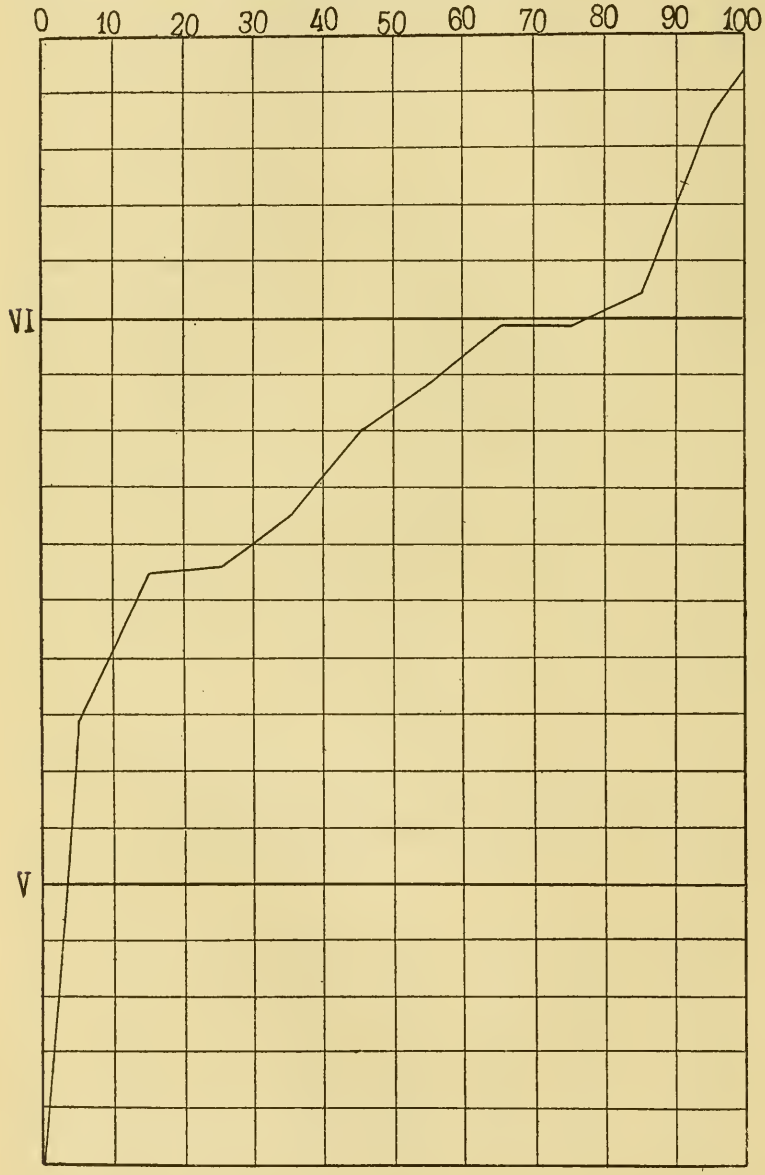
School Standing of the Different Percentile Groups.

Showing the average number of grades made by the pupils coming under the various percentile groups for the different measurements.

Percentile Groups	Net Height	Height Sitting	Weight	Grip of R. Hand	Grip of Left Hand	Vital Capacity	Work on Ergogr'ph
100	6:44	6:69	6:60	6:21	6:24	6:55	6:44
90–100	6:36	6:07	6:26	6:09	6:09	6:29	6:00
80–90	6:04	6:07	6:0	6:03	5:97	6:03	5:96
70–80	5:98	5:98	5:89	5:91	5:91	5:96	5:80
60–70	5:98	5:85	5:86	5:87	5:89	5:93	5:86
50–60	5:88	5:80	5:77	5:87	5:79	5:81	5:83
40–50	5:80	5:75	5:77	5:72	5:74	5:79	5:85
30–40	5:65	5:73	5:72	5:64	5:73	5:76	5:76
20–30	5:56	5:65	5:71	5:62	5:67	5:67	5:74
10–20	5:55	5:54	5:55	5:59	5:54	5:59	5:65
0–10	5:29	5:43	5:38	5:43	5:49	5:36	5:56
0	4:50	4:70	4:66	5:12	5:11	4:85	4:72

CHART XIII.

School Standing of the Different Percentile Groups in Reference to Net Height.
Based on Data in Table VI.



TESTING MOTOR ABILITY.

MOTOR ABILITY.

Quickness of movement was tested by determining with what rapidity the child could tap with a metallic pencil upon a platinum plate. An electric recorder registered the number of taps. The recorder consists of a ratchet and pawl controlled by an electro-magnet and operating hands over a dial. The electric circuit is completed by touching the metallic pencil to the plantinum plate. The work was timed by an ordinary stop watch. The child took the pencil and tapped as rapidly as he could upon the platinum plate, the number of separate contacts made in thirty seconds being recorded as the index of his quickness of muscular action. This test of motor ability was made on the pupils of the Ogden Elementary School, the Lake High School and the John Worthy School. Although the number of pupils thus tested is small, yet sufficient data have been compiled for fairly establishing certain important truths. Table VII shows the development of motor ability. It will be noted from this table that while the boys have greater muscular control, as shown by quickness of movement, than the girls, yet the difference is slight as compared with the differenc in power of the sexes as shown in the tests of strength, endurance and vital capacity. (See Report No. 2, pp. 11-23.)

TABLE VII.

DEVELOPMENT OF MOTOR-ABILITY

AGE.	BOYS.			GIRLS.		
	Number Tested.	Number of Taps.		Number Tested.	Number of Taps.	
		Right Hand.	Left Hand.		Right Hand.	Left Hand.
8	31	147	117	31	146	117
9	60	151	127	44	149	118
10	47	161	132	48	157	129
11	49	169	141	48	169	139
12	44	170	145	50	169	140
13	50	184	156	45	178	153
14	40	184	155	67	181	157
15	37	191	169	48	181	159
16	21	196	170	50	188	167
17	13	196	174	40	184	162
18	3	197	183	24	193	169

MOTOR ABILITY AND SCHOOL STANDING.

From Table VIII it will be seen that the more advanced pupils—those at and above grade—have on the average made better records in motor ability than those below the normal grade for their age, thus showing that the brighter pupils have better muscular control, as shown by quickness of movement, than the dull pupils. It will be seen also from Table VIII that the pupils of the John Worthy School are, on the whole, behind even the backward pupils of the other schools in motor ability.

TABLE VIII.

MOTOR ABILITY AND SCHOOL STANDING.

Age.		No. Tested.	No. of Taps R. Hand.	No. of Taps L. Hand.	Per cent L. Hand is of R. Hand.
9	At or above grade	61	152	124	82
	Below grade	43	147	122	83
	John Worthy School	4	162	132	81
10	At or above grade	52	160	133	83
	Below grade	43	147	127	86
	John Worthy School	15	155	131	84
11	At or above grade	64	172	145	84
	Below grade	32	162	131	81
	John Worthy School	27	150	127	84
12	At or above grade	41	172	146	85
	Below grade	53	168	140	83
	John Worthy School	45	158	140	88
13	At or above grade	55	183	154	84
	Below grade	40	179	152	86
	John Worthy School	67	163	142	87
14	At or above grade	50	185	156	84
	Below grade	57	180	156	87
	John Worthy School	75	169	146	87
15	At or above grade	46	199	165	84
	Below grade	39	184	161	87
	John Worthy School	58	171	149	88
16	At or above grade	39	191	165	86
	Below grade	32	190	167	88
	John Worthy School	13	178	154	87
17	At or above grade	31	196	168	86
	Below grade	22	178	160	90
	John Worthy School	7	169	152	90
18	At or above grade	13	200	174	87
	Below grade	14	198	177	89

RIGHT-HANDEDNESS AND SCHOOL STANDING.

In the report of last year (pp. 48-50) it was pointed out that on the whole the brightest pupils are more decidedly unidextrous than the average pupils; the average pupils are more unidextrous than the dull pupils, and they, in their turn, are more decidedly unidextrous than the pupils of the John Worthy School. These conclusions were based on tests of strength. From our tests of motor control, as shown by quickness of movement, the same truth appears. From Table VIII it will be seen that the number of taps made by the left hand is a smaller per cent of the number of taps made by the right among those at and above grade than among those below grade, and, on the whole, among the boys of the John Worthy School the left hand more nearly approaches the right in motor ability than among the backward pupils of the ordinary school, thus again showing that the unidextrous condition is the ideal condition of motor development for most pupils. Every occupation makes demands for some kind of skill in the use of the less expert hand, but the attempt on the part of the teachers to go beyond this and try to develop ambidexterity, by causing pupils to do with the less expert hand things that their natural impulses would lead them to do with the more efficient hand, seems, in the light of this evidence, to be teaching contrary to the natural law of child development.

MEMORY INVESTIGATION.

An investigation of some of the phenomena of memory was undertaken with two special objects: First, to establish norms for use in the examination of special cases; second, to gain light on the teaching of spelling. This second practical pedagogical problem was undertaken at the request of Superintendent Cooley. It is hoped that, later on, added data will enable us to make this report more complete. The scope of the work can best be seen from the following copy of the card on which the data were recorded:

Form C. S. & P. I. No. 5.

BOARD OF EDUCATION
City of Chicago

No.....

EDUCATIONAL DEPARTMENT
Room 1200 Schiller Bldg.

Name.....

Grade.....No. of weeks in this Grade.....

School.....Room No.....

Teacher.....

Date of Birth—Year.....Month.....Day.....

Place of birth.....

Place of birth of father.....

Place of birth of mother.....

School Standing .....

Attention.....

Memory.....

Judgment.....

Best work is in.....

Poorest work is in.....

Deportment.....

How taught spelling.....

Date.....						
Age.....						
Visual Acuity, R.....						
do. L.....						
Acuteness of hearing, R.....						
do. L.....						
Motor ability, R.....						
do. L.....						
MEMORY-SPAN TEST:						
Auditory memory.....						
Visual Memory						
Audio-visual.....						
Audio-visual-articulatory						
Audio-visual-hand-motor.....						
SPELLING TEST:						
Auditory memory.....						
Visual memory.....						

The data to be recorded upon the upper part of the card were furnished in part by the pupil himself and in part by his teacher. Careful check tests were made on sight, hearing and motor ability. Later, measurements were taken of height, height sitting, weight, strength of grip of the right and the left hand and vital capacity.

METHOD.—For the purpose of investigating the native power of immediate sense memory of the children of different ages, memory-span tests were made in the following manner: Figures were arranged in series of different lengths of from four to eight digits each, only the nine significant digits being used. These series were printed in very large type on cards. A set constituting a test consisted of ten series, two series of four digits, two of five each, two of six, two of seven and two of eight. The following is a specimen set of the series used in a test:

5 1 6 2	2 9 6 8 5
6 8 4 7 3 5	8 6 3 7 1 9
7 4 2 8 3 5 8 1	4 7 9 2 1 8 3
6 3 9 2 7	9 3 2 4
3 9 1 5 8 4 6	2 9 5 8 4 7 6 3

In order that the matter might be as homogeneous a mass of material as possible, an attempt was made to avoid all previously established associations. To this end care was taken that in no case should two digits come in their natural order, as 3, 4, nor were they in any case arranged in their reverse order, as 8, 7. Series representing familiar dates were avoided. A sufficient number of series were thus produced so that no set was presented twice to the same pupils.

The tests were made on all the pupils of a room at once, by having the pupils reproduce the series on specially prepared blanks. These papers were collected and carefully graded. The errors were checked and the percentage correctly recorded constituted the grade for that test. Seven tests were taken during the day, an hour intervening between the tests. The average made by each pupil in these seven tests constituted his final grade. The compilations include 25,000 individual tests of ten series each.

The series of four digits proved to be easy enough for those with the poorest memory, and the series of eight digits was difficult enough for all except the brightest pupils of the highest grades. In the higher grades were some pupils who probably could have remembered a longer span than eight had such a series been given them in the test; so the final percentages made in the upper grades do not show the full memory power as compared with those in the lower grades. On the other hand, the amount of attention required for writing the figures was greater with the younger pupils, and on this account the percentages made by them probably fall short of showing their full memory power.

It will be seen that in this investigation the attempt has been made to test the native memory power of the child rather than his previous acquirements and school training, as is done in the ordinary examinations, which test knowledge primarily and power only incidentally.

METHOD IN AUDITORY MEMORY.

In order to test the auditory memory a series of digits, as 6, 8, 5, 3, was read to the pupils at a uniform rate of speed and a degree of loudness that was clearly perceptible by all. In the reading care was taken to avoid all rhythm. After a lapse of about five seconds the child was allowed to write this series. The reading was regulated by a metronome beating ninety times a minute. The ten series constituting a set were so arranged that the child could not anticipate the number of digits constituting the series about to be read; nevertheless, a series was given first which would be within the memory span of nearly all the pupils, because it was believed that by using one of the shorter series at first the children would be encouraged, whereas if a span beyond their power to reproduce was given first, some might lose heart and so not put forth their most intense power of attention.

METHOD IN VISUAL MEMORY.

In testing visual memory, the card on which the series was printed, after the usual warning, was held before the pupils the same length of time that would have been consumed in reading the series in the auditory tests, namely, two-thirds of a second for each digit composing the series. The type used in printing the

TESTING VISUAL MEMORY.

card was of such a size that it could be read by the normal eye at a far greater distance than that actually required of any pupil, but at the same time opportunity was given to anyone who experienced difficulty in seeing the figures to change his seat. The figures of a series were not exposed one at a time, and undoubtedly many of the children ran their eyes several times over the line of figures exposed, and so secured the advantage of repetition, which the child did not have in the auditory test. While it would have been easy to have arranged a shutter so as to expose one figure at a time, it was not considered best to do so, as this opportunity for repetition is a natural advantage which one usually has in learning through the eye. While a more rapid rate might be used as far as auditory and visual memory are concerned, and still allow time for clear and distinct enunciation, yet the longer period was selected in order to allow sufficient time for the audio-visual-articulatory and the audio-visual-hand-motor tests. It is believed that the slow rate was slightly to the advantage of the visual memory in comparison with the auditory memory.

METHOD IN AUDIO-VISUAL MEMORY.

In the audio-visual test a card containing the series was exposed to view just as in the visual test, and at the same time the digits were repeated aloud by the experimenter at the rate used in the auditory test. Thus a simultaneous appeal was made to the sight and hearing of the pupils.

METHOD IN AUDIO-VISUAL-ARTICULATORY MEMORY.

In the test of the audio-visual-articulatory memory the impression was produced by making a simultaneous appeal to hearing, sight and the muscle sense by having the series read aloud by the pupils when the card containing the digits was presented, the concert reading being timed by the metronome.

METHOD IN AUDIO-VISUAL-HAND-MOTOR MEMORY.

While the series was dictated at the established rate, the pupils wrote the digits on scrap paper and at the close of the series the paper was turned face downward and the pupils repro-

duced the series from memory upon the test paper, thus testing the result of a simultaneous appeal to hearing, sight and the sensations from the muscles used in writing.

NO COMPLETE SEPARATION OF THE DIFFERENT SENSE MEMORIES.

While the attempt was made to test the immediate sense memory from the exercise of sight, hearing and the combined action of these senses with each other and with the muscle sense awakened by activity in the hand and vocal organs, yet these elements could not be tested as isolated memories. It must be remembered that the muscle sense enters into our activities of both sight and hearing in the reception of the impression, because both the eye and ear require the action of muscles for their adjustment. In testing visual memory, it was noted that many children, in spite of all admonitions to the contrary, moved their lips and throats, thus indicating that articulatory impressions were awakened. Even in the auditory tests slight lip movements were noted in some pupils. In the recording of the figures of any series the impressions of course had to be translated into visual and motor terms, so that probably the sight, hearing and motor tracts and centers were active during all the tests; yet nevertheless it is believed that the predominating elements are the ones named in each test.

FATIGUE.

It is well known that extreme fatigue lowers the memory power. The tests were made at the different periods of the day with the thought of ascertaining whether any trace of the course of power during the day, as established by the ergograph, would appear from these memory tests, but it seems that the children on the whole gained more through practice than they lost through fatigue. There is but a slight falling away just previous to the noon hour and again in the afternoon just before the close of school.

THE DEVELOPMENT OF AUDITORY AND VISUAL MEMORY POWER.

Table IX, Chart XIV, shows the development of the auditory and visual memory. While there are a number of irregularities

in the curves of this chart, which are due simply to the paucity of numbers, yet certain facts seem to be thoroughly established. The auditory memory develops rapidly up to about fourteen years of age, and but slowly after this period. The visual memory seems to develop rapidly up to fifteen or sixteen years of age. This period of rapid development of visual memory lasts a year or two longer than the period of rapid development of auditory memory. It will be noted that in the early life of the child the auditory memory is stronger than the visual memory; after about nine years of age the visual memory of most of the children becomes stronger than the auditory, and continues to develop more rapidly than the auditory memory throughout school life. Yet even in the high school there still remains a small proportion of the pupils whose hearing memory is the stronger. This small percentage of persistently ear-minded individuals, like the small per cent of left-handed people, seems to be a special provision of nature to show to teachers that children are not alike mentally or physically and are not all to be subjected to the same treatment; that children are not so plastic as educators seem to think them to be, and that school training, important as it is in the development of human power, is often overestimated when compared with the great factors—heredity and nutrition.

The investigation shows, too, that there is no "memory period;" no period in early school life when the memory is stronger than it is at any later portion of the child's life, a period especially adapted to memorizing.

TABLE IX.

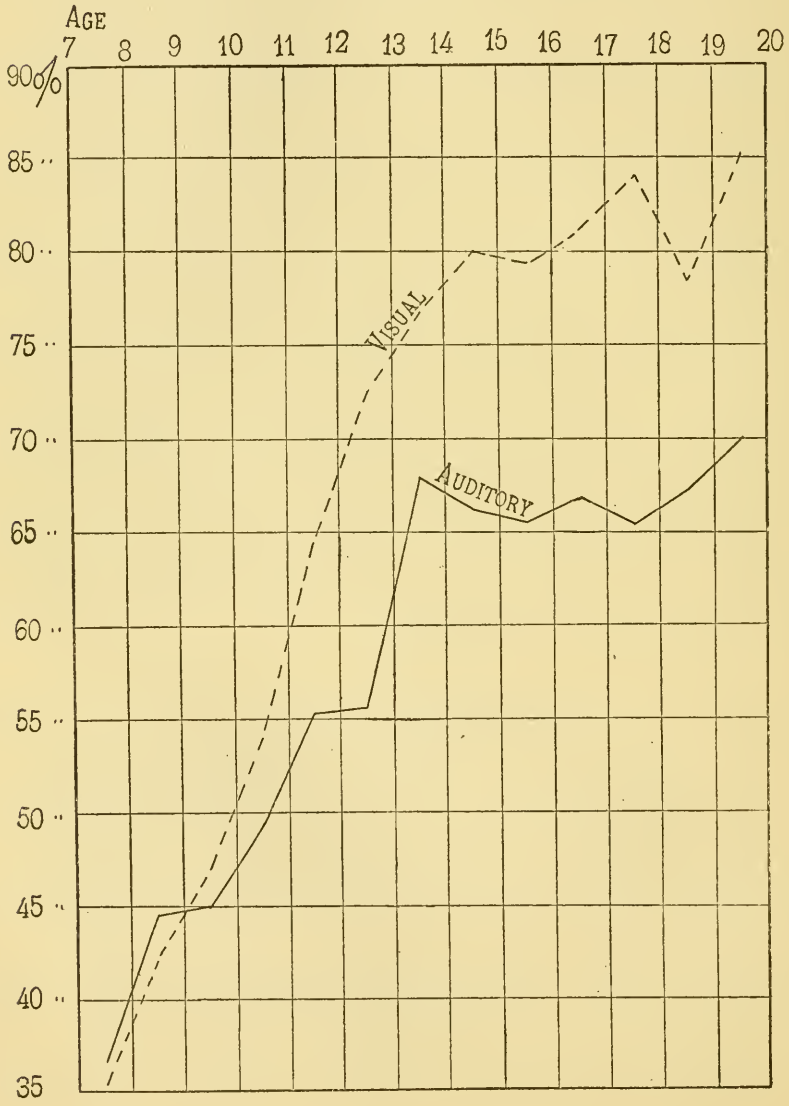
THE DEVELOPMENT OF MEMORY.

Average Age.	No. Tested.	Auditory, Per Cent.	Visual, Per Cent.
7 yrs. 8 mo. 9 da.	19	36.4	35.2
8 yrs. 5 mo. 24 da.	58	44.6	42.8
9 yrs. 6 mo. 6 da.	100	45.	47.4
10 yrs. 5 mo. 3 da.	89	49.4	54.6
11 yrs. 5 mo. 17 da.	91	55.4	64.7
12 yrs. 6 mo. 3 da.	93	55.7	72.3
13 yrs. 6 mo. 21 da.	109	57.9	76.8
14 yrs. 5 mo. 28 da.	114	66.2	80.5
15 yrs. 6 mo. 1 da.	94	65.6	78.2
16 yrs. 6 mo. 4 da.	77	66.9	81.3
17 yrs. 5 mo. 20 da.	56	65.5	84.1
18 yrs. 5 mo. 3 da.	25	67.2	77.5
19 yrs. 5 mo. 11 da.	12	70.	85.3

CHART XIV.

Development of Memory.

Based on Data in Table IX.



BEARING OF SENSORY DEFECTS.

It might readily be suspected that the sight and hearing defects of the pupils, in spite of all care, might seriously influence the results in the tests of auditory and visual memory; thus, in the visual test, if the child failed to see the figures clearly, he could not be expected to reproduce them correctly; and in a few cases papers had to be discarded because the errors proved to be clearly due to defective vision. To ascertain the probable effect the sensory defects had upon the results of the memory tests, certain compilations in regard to the sensory defects of the pupils tested were made. Of the pupils who stood above the average for their age in auditory memory, 32 per cent were slightly subnormal in visual acuity and 10 per cent were slightly defective in hearing. Of the pupils below the average for their age in auditory memory, 41 per cent were slightly subnormal in vision and 14 per cent were somewhat defective in hearing. Of the pupils who stood above the average in visual memory, 32 per cent were slightly defective in vision and 10 per cent defective in hearing. Of the pupils below the average of their age in visual memory, 45 per cent had defective sight and 15 per cent defective hearing. It will be seen that in both auditory and visual memory those above the average have a smaller per cent of defects than those below the average, but the fact that those below the average in auditory memory have no larger per cent of hearing defects than those below the average in visual memory would seem to indicate that the hearing defects played but a small part, if any, in these tests; and so in visual memory, the fact that the percentage of those below the average with defective eyesight does not much exceed the per cent of those below the average in auditory memory with defective eyesight would seem to indicate that eye defects played but a minor part in the tests in visual memory.

AUDIO-VISUAL MEMORY.

It has been pointed out that during early school life the auditory memory is the stronger; later the visual memory is the stronger. It will be seen in Table IX that during the whole of school life the audio-visual memory is stronger than either the auditory or the visual; that is, a simultaneous appeal to both

sight and hearing produces a deeper impression than is brought about by an appeal to either sense alone. This fact is very far-reaching in its application to teaching.

AUDIO-VISUAL-ARTICULATORY AND AUDIO-VISUAL-HAND-MOTOR MEMORIES.

It will also be seen from Table X that the audio-visual-articulatory memory, in which the impression is produced by an appeal to hearing, sight and the muscle sense, is even stronger than the audio-visual. It would seem that, as a general rule, the more senses we can appeal to, the richer and more usable and probably the more lasting will be the impression. Yet the audio-visual-hand-motor memory, while stronger than the auditory or the visual, is not quite so strong as the audio-visual or the audio-visual-articulatory. It would seem that the divided attention required in writing the digits when dictated interferes slightly with their firm grasp in memory.

TABLE X.

COMBINED SENSE MEMORIES.

Age at Last Birthday.	No. Tested.	Audio-Visual, Per Cent.	Audio-Visual-Articulatory, Per Cent.	Audio-Visual-Hand-Motor, Per Cent.
7	19	43.8	47.4	....
8	60	50.2	50.	....
9	99	56.1	53.3	55.9
10	93	57.4	62.8	63.3
11	91	70.9	74.6	68.8
12	92	74.8	76.9	71.7
13	97	82.9	84.8	79.3
14	80	82.6	86.	81.1
15	45	80.7	81.4	78.9
16	18	86.9	88.4	82.4

MEMORY-SPAN.

In order to have a simple standard for determining whether an individual is equal to, above or below others of his age in memory power, the memory span for each age from eight to nineteen years, inclusive, has been determined in the following manner: If a child could remember a series of a given length so as to write it perfectly at least one-half the time, it was con-

sidered within his memory span. In determining the average memory span, the first four trials of each pupil on a series of a given length were taken as a basis for computation. If a majority of the pupils of a given age could reproduce correctly series of a given length in at least one-half of the trials, it was considered within the memory span for that age. For example, of the twelve-year-old pupils, 47 out of 93 reproduced correctly two or more of the first four visual tests given them on a series of seven digits, so seven is within the visual memory span for the twelve-year-olds. In this manner the following table of memory span has been established:

TABLE XI.

MEMORY-SPAN.

Age.	Auditory Memory.	Visual Memory.	Age.	Auditory Memory.	Visual Memory.
7	5 digits.	5 digits.	14	6 digits.	7 digits.
8	5 "	5 "	15	6 "	7 "
9	5 "	6 "	16	6 "	7 "
10	6 "	6 "	17	7 "	8 "
11	6 "	6 "	18	6 "	7 "
12	6 "	7 "	19	7 "	8 "
13	6 "	7 "			

REPETITION.

To test the effect of repetition a schoolroom was selected containing thirty-eight pupils, averaging ten years and twenty-seven days old. The first test given was the usual auditory test. On this the pupils made an average of forty-seven per cent. In the second test each series was read to the pupils and then immediately reread at the same rate. On this test an average of fifty-five per cent was made. In the next test each series was read three times, the pupils making an average of fifty-nine per cent.

MEMORY POWER AND SCHOOL STANDING.

The ninety-three twelve-year-old pupils found in the Ogden School were scattered throughout the grades, from the third to the eighth, inclusive. From Table XII, Chart XV, it will appear that those twelve-year-old pupils found in the higher grades have

stronger memory power than those of the same age in the lower grades. Not only is this true, but we find that the twelve-year-old pupils of the eighth grade, who are the youngest pupils of this grade, are decidedly superior in memory power to the average eighth grade pupils, thus indicating that their superior native memory power has been a potent factor in putting them two years ahead of their normal grade.

To show how decidedly this parallelism between superior school standing and memory power holds good throughout school life, the pupils have been divided into two groups, one representing those at or above the normal grade for that age, the other those below the normal grade for that year representing the backward pupils. The normal grade for that age was found by subtracting six from that age; thus, a pupil of twelve years would be found normally in the sixth grade; if in the fifth or lower grade he would be classed as below grade; if in the sixth, seventh or eighth grade he would be classed as above grade. The result of this compilation appears in Table XIII. Charts XVI and XVII.

TABLE XII.

MEMORY POWER OF TWELVE-YEAR-OLD PUPILS BY GRADES.

Grades	3	4	5	6	7	8
No. Tested	7	11	30	25	15	5
Auditory	43.3%	50.8%	54.7%	61.9%	60.3%	71.8%
Visual	56.7%	63.8%	71.8%	73%	76.9%	92.8%

TABLE XIII.

MEMORY AND SCHOOL STANDING.

AGE.	No. TESTED.	AUDITORY.		VISUAL.	
		Av. Standing of Pupils At and Above Grade.	Av. Standing of Pupils Below Grade.	Av. Standing of Pupils At and Above Grade.	Av. Standing of Pupils Below Grade.
9	99	47.8 %	39.7 %	50.3 %	41.9 %
10	88	54.4 "	42.7 "	61.6 "	46.2 "
11	91	59.0 "	48.6 "	69.4 "	53.3 "
12	92	62.6 "	52.2 "	76.7 "	66.0 "
13	110	70.4 "	64.3 "	80.7 "	72.3 "
14	116	68.9 "	62.6 "	87.6 "	74.9 "
15	94	68.9 "	62.4 "	80.9 "	75.0 "
16	75	70.1 "	65.8 "	83.3 "	78.8 "
17	56	67.5 "	62.7 "	87.8 "	81.2 "

CHART XV.

Memory Power of the Twelve-year-old Pupils by Grades.

Based on Data in Table XII.

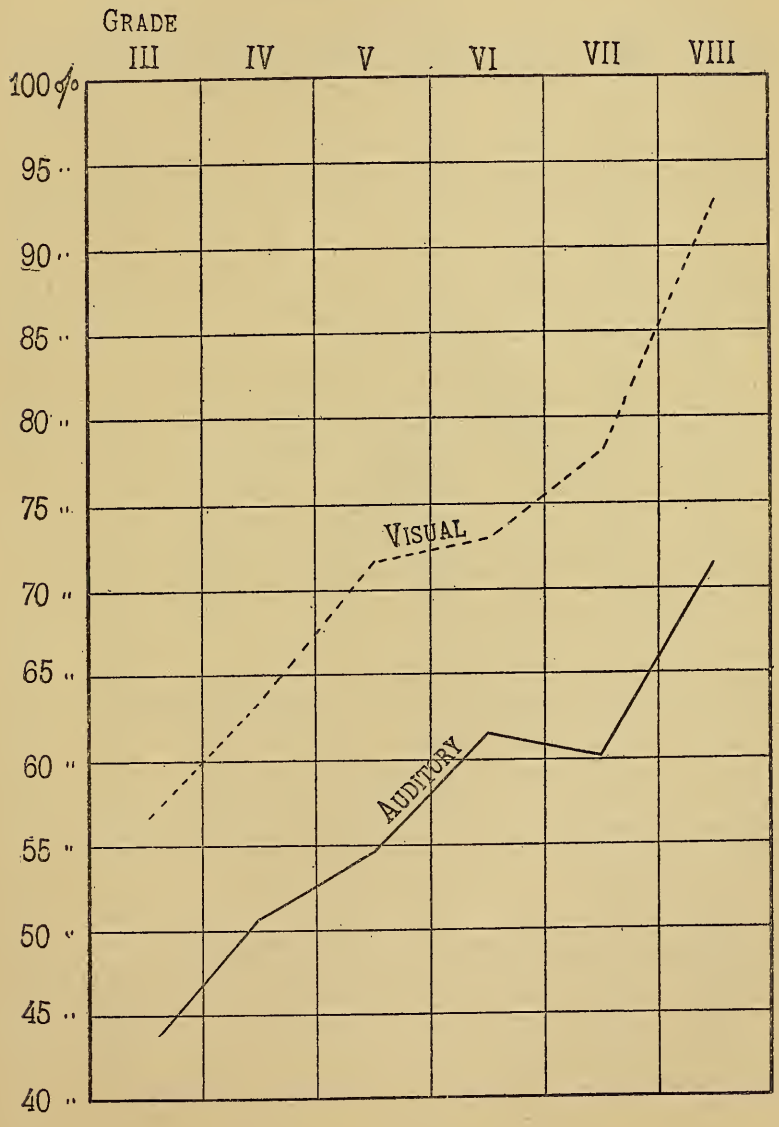


CHART XVI.

Auditory Memory and School Standing.

Based on Data in Table XIII.

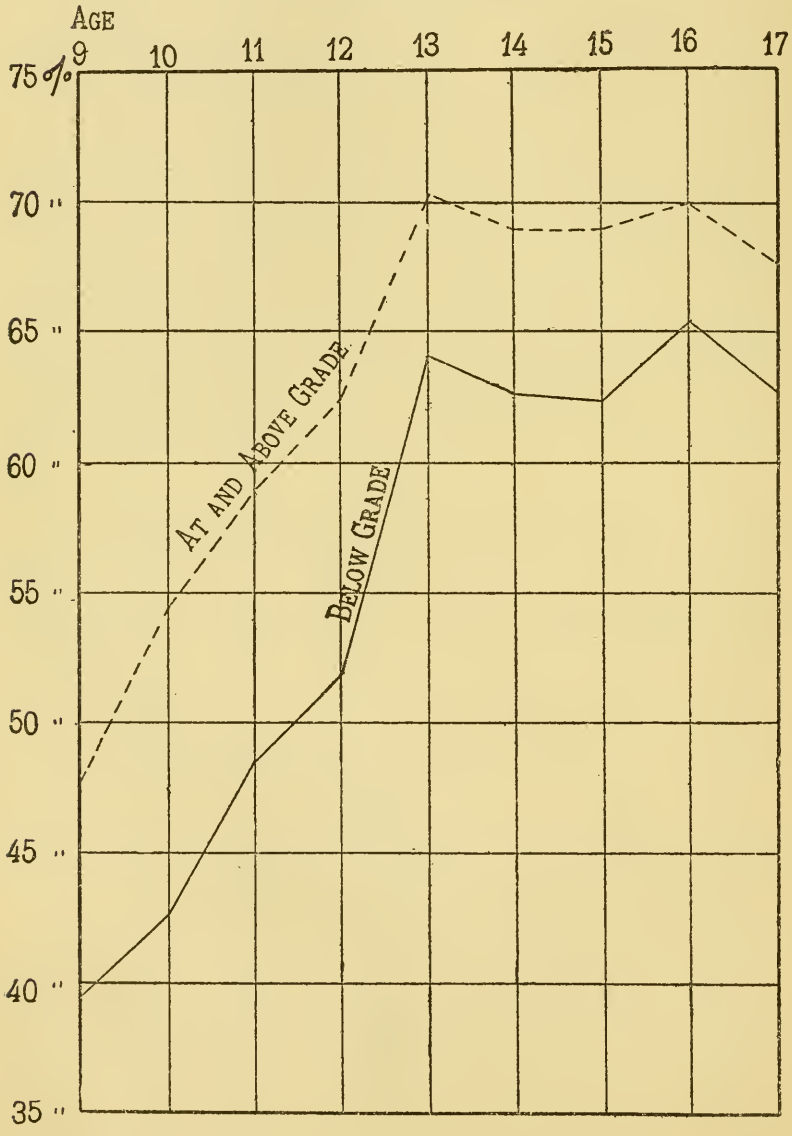
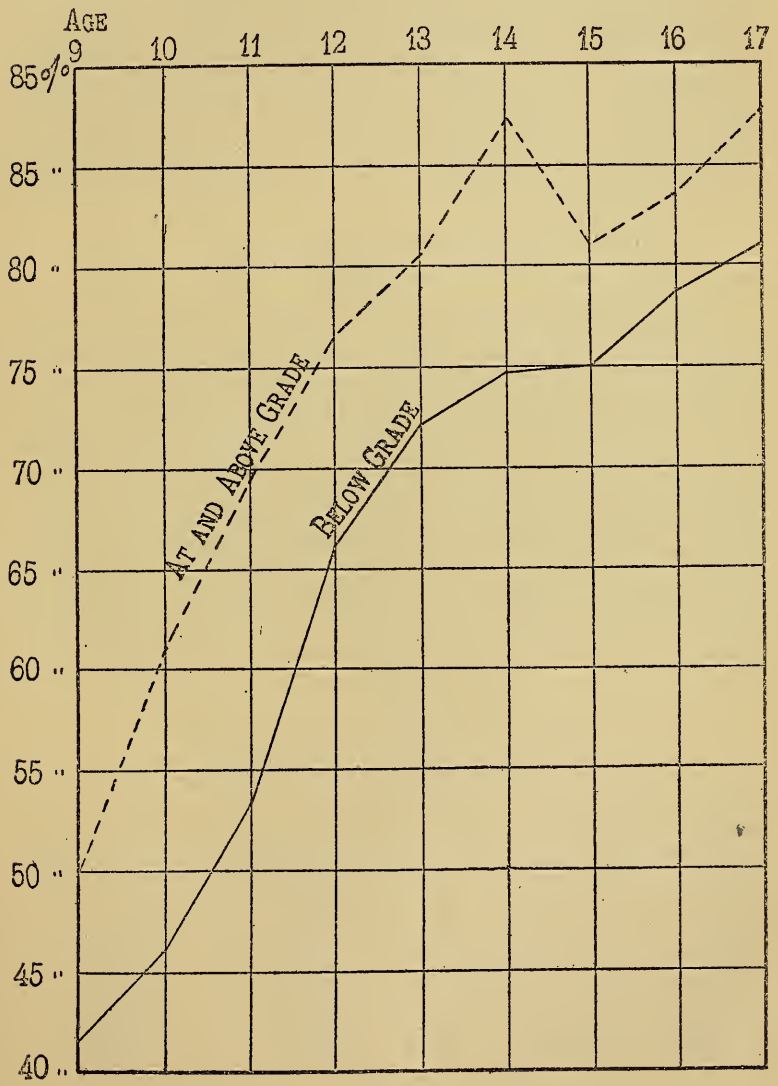


CHART XVII.

Visual Memory and School Standing.

Based on Data in Table XIII.



BALANCE OF SENSE MEMORY.

Chart XIV, Table IX, shows that on the average the visual memory develops more rapidly than the auditory memory. It appears from Chart XV, Table XII, that the more advanced twelve-year-old pupils have visual memory stronger in proportion to the auditory memory than do the backward pupils of this age. If we take the pupils from nine to seventeen years of age, we find that only sixteen per cent of those at or above grade have the auditory memory stronger than the visual, while twenty-one per cent of those below grade have the auditory memory stronger.

COMPARISON OF MEMORY POWER AND PHYSICAL CONDITION.

Table XIV gives a comparison of all those above the average with those below the average for their age in memory power in reference to the physical tests. It will be seen from this table that those who are higher in memory power are larger and better developed physically than those below the average in memory. This physical superiority is slight, yet the difference in memory power between those above the average and those below the average is but small, for most of the pupils are only slightly removed from the average in memory power. That those with superior memory power are larger and in a better physical condition, as shown by the physical tests, suggests that the immediate sense memory is dependent upon good brain formation and nutrition.

TABLE XIV.

Comparison of Memory Power and Physical Condition.

AUDITORY MEMORY.

Physical Measurements.	Above the Average.	Below the Average.
Net height	1485 mm.	1464 mm.
Height sitting	795 mm.	785 mm.
Weight	40.706 kg.	39.793 kg.
Strength of right hand	23.07 kg.	22.29 kg.
Strength of left hand	21.41 kg.	20.77 kg.
Vital capacity	2089 ccm.	2019 ccm.
Motor ability of right hand	176 taps.	174 taps.
Motor ability of left hand	148 taps.	146 taps.

TABLE XIV—Continued.

VISUAL MEMORY.

Physical Measurements.	Above the Average.	Below the Average,
Net height	1484 mm.	1468 mm.
Height sitting	785 mm.	784 mm.
Weight	40.561 kg.	39.435 kg.
Strength of right hand	22.65 kg.	22.23 kg.
Strength of left hand	20.97 kg.	20.69 kg.
Vital capacity	2091 ccm.	1987 ccm.
Motor ability of right hand	180 taps.	169 taps.
Motor ability of left hand	155 taps.	144 taps.

BOYS OF THE JOHN WORTHY SCHOOL.

Tests in auditory and visual memory were made on the pupils of the John Worthy School. Nearly one-fourth of these pupils could not be tested after the manner in which the tests were made in the public schools, because the pupils were not far enough advanced in scholarship to write the figures which were read to them. Although on this account the averages are probably much higher than they otherwise would be, yet it will be noted from Table XV that the boys of the John Worthy School are lower in memory power than are the pupils of the other schools, and that this disparity increases with age.

TABLE XV.

Memory Power of the John Worthy Boys.

AUDITORY.

Age.	No. Tested.	Average Per Cent.	Normal for this Age.	Per Cent John Worthy is of Normal.
9	1	38	45	84
10	6	48	49	89
11	21	42	55	76
12	33	48	56	86
13	49	49	68	72
14	65	48	66	73
15	53	53	66	80
16	13	61	67	91
17	5	41	66	62

TABLE XV—Continued.

VISUAL.

Age.	No. Tested,	Average Per Cent.	Normal for this Age.	Per Cent John Worthy is of Normal.
9	1	53	47	113
10	6	58	55	105
11	21	56	65	86
12	33	65	72	90
13	49	66	77	86
14	65	60	81	74
15	53	72	78	91
16	13	78	81	96
17	5	56	84	67

SPELLING TEST.

In order to determine how the power of auditory memory compares with visual memory when actually employed in learning to spell, tests were given in the following manner: Two lists of seventy words each were prepared, and each list divided into seven sets of ten words each. These words were believed by the principal and teachers to be in the speaking vocabulary of all the pupils. Seven tests of ten words each were given during the day at intervals of one hour. Instead of allowing the pupils to write the word immediately after its presentation, as in the work with figures, the ten words were presented one at a time and then were pronounced, to be written as in the ordinary spelling exercise.

The first day the seven sets of the first list were given as auditory tests, and the next day the sets of the second list were used as visual tests. Of course, it was impossible to make lists of words of exactly equal difficulty. To obviate this the tests were repeated one week later. The exercises were given as before, except that the words used as auditory were given as visual tests in the second trial, and vice versa. So each word was used twice—once in an auditory test and once in a visual test. On compiling the results we find an average standing of sixty-four per cent in the auditory tests and seventy-three per cent in the visual. The striking similarity in the comparative strength of auditory and visual memory, as shown in this spelling test and in the test

of the same pupils with figures, serves to strengthen the belief that many of the conclusions drawn from the memory tests are applicable to the learning of spelling.

COMPARISON OF GOOD AND BAD SPELLING.

Each teacher in the Ogden School furnished the names of the five poorest and the five best spellers of her room. This gave an opportunity to study the characteristics of good and bad spellers. While on the whole the good spellers have decidedly better memory power than the bad spellers, yet there are individuals among the poor spellers who are superior in memory power, and individuals among the best spellers whose memory power is scarcely up to the average of their age. While this native power of sense memory plays an important role, it is by no means the only factor in learning to spell.

It should be added, also, that while the number of sight and hearing defects is greater among the poor spellers, yet there are among the very best spellers pupils with marked sensory defects.

SOME CONCLUSIONS AND SUGGESTIONS.

1. In these tests of memory an attempt has been made to divest the matter to be memorized of as many associations as possible, and so to measure the native strength of the memory. The power thus measured is passive; it is blind; it attempts to take and give back without change, to return an echo of the sensations. It shows what the child can apprehend, not what he can comprehend. Good teaching attempts to make the mind active and alert, causing it to compare, associate and classify. It is the province of the school to discipline this native power of memory; to bring forth skill where originally there is only strength. The teacher should aim to develop from the native sense memory an organized rational memory. It is said that English spelling is illogical, but this is true in part only, and the teacher should use every available opportunity to see that the child uses his rational memory instead of depending too largely on the native force of his sense memory.

2. Those with superior memory power being in superior physical condition, as shown by the anthropometric tests, clearly indicates that the immediate sense memory is dependent upon good brain formation and nutrition. The skillful and rational use

of this memory power is dependent upon habitual use, hence on education and experience. All these factors are significant in learning to spell.

3. Where the matter memorized has been divested of associations, repetition is necessary for the securing of deep and lasting impressions. Wherever logical association is possible, there can be a more efficacious method of study. In studying, the child should be habituated to depend upon comparing and classifying, rather than upon mere repetition. Children are so prone to depend upon blind repetition that they sometimes put forth as much effort in studying the words that they have long thoroughly known as they do upon unfamiliar words, and use as much energy in studying the parts of a word that present no difficulty as they do upon the unknown portions. A wise direction of the child's energies would greatly shorten the time necessary for the mastery of English orthography.

4. While usually the better spellers are possessed of better memory power than are the poor spellers, yet there are bad spellers with a high development of memory. Superior memory may make the acquisition of spelling easy, yet it by no means removes the necessity for some intelligent application on the part of the pupil. While most good spellers tend toward the visual type, still there are both good and bad spellers of each type.

5. The fact that children have the ear memory stronger during the early years suggests at once that the teaching of spelling to the young will be effective if the ear is appealed to; that there is probably a place for oral spelling; that there should be some pronunciation of syllables with the spelling; that the words presented to the child at first should be, as far as possible, phonetic in their spelling, leaving the "more cruel and unusual" forms of English orthography to be learned in later years when the eye memory has become stronger.

6. The investigation shows that there is no "memory period," no period in early school life when the memory is stronger than it is at any later portion of the child's life, a period especially adapted for learning to spell. While there are no memory stages, there are undoubtedly periods of interest that are especially favorable for the child's learning to spell; times when, through the influence of companions or teachers, the child is aroused from indifference or from a feeling that spelling is a small part of life to a recognition that it is important.

7. It has been pointed out that during early school life the auditory memory is the stronger, and later that the visual memory is stronger. During the whole of school life the audio-visual memory is stronger than either the auditory or visual; that is, a simultaneous appeal to both sight and hearing produces a richer and more usable image than is brought about by an appeal to either sense alone. This fact is very far-reaching in its application to teaching. The audio-visual-articulatory memory, in which the impression is produced by an appeal to the hearing, sight and the muscle sense, is even stronger than the audio-visual. It would seem from this that the more senses we can appeal to, the deeper will be the impression. This fact should be made use of in spelling drills.

8. The aim in teaching spelling should be to render words of the most frequent use automatic, to have them so well known that in writing they will flow from the point of the pen, requiring but little thought as to their formation. Then there is a large class of words of less frequent occurrence which should be recalled on slight reflection. For the more unusual words the individual should have the dictionary habit so firmly fixed that he will conscientiously look up every word he needs to write if in doubt about its correct spelling. The spelling of words is rendered automatic through practice in writing them. Though the first grasp of the word may well be made through other combinations of sense memories, yet the final retention of the spelling of most words should be through the audio-visual-hand-motor memory.

9. The per cent of pupils having sight and hearing defects is greater among the poor spellers than among the good spellers; yet there are pupils with decided sensory defects among the very best spellers. While these sensory defects are handicaps in learning to spell, still they may be overcome, through careful application, by those pupils who have good memory power.

10. Much that has been said here concerning the teaching of spelling will apply with but slightly diminished force to instruction in the other branches of the curriculum.

Respectfully submitted,

FRED WARREN SMEDLEY,

Director of the Department of Child-Study and Pedagogic Investigation.

Chicago Public Schools

Report of the Department of Child Study and Pedagogic Investigation...1902-1903

D. P. Mac Millan, Ph. D.
Director

Child-Study Report Number 4

CHICAGO PUBLIC SCHOOLS

Report of the Department of

Child-Study

AND

Pedagogic Investigation

1902-1903

CHILD-STUDY REPORT No. 4

LB1103
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By transfer
AUG 23 1910

Report of the Department of Child-Study and Pedagogic Investigation

Mr. E. G. Cooley, Superintendent of Schools:

Dear Sir—The following report of the work of the Department of Child Study and Pedagogic Investigation, for the school year ending June 30, 1903, is respectfully submitted:

The report naturally falls under two main heads: first, the practical or applied work, and secondly, that of investigation.

The practical work included the following:

1. The examination of the children in the rooms for the deaf.
2. The examinations made of the children sent to the central laboratory during the school year.
3. The physical examination of teachers and cadets entering the teaching corps, and of candidates for entrance to the Normal School.
4. The child study work carried on at the Parental School, a brief report of which can be found in the First Annual Report of the Chicago Parental School, page 32.

In the line of investigation is detailed, first the pedagogical. This was centered around three of the school activities or studies: spelling, writing and reading.

The second line of investigation was the more distinctly psychological, and while data for the general scheme of the department is not yet ready for publication, an offshoot of it is briefly stated, because of its intimate connection with the work already completed and published in Report No. 3. This is the investigation on memory for significant combinations, (i. e., combinations with meaning) and its comparative growth as compared with that of memory for relatively non-significant symbols.

LABORATORY CASES.

A central laboratory is maintained at the offices of the Board of Education, where children are brought by principals, parents or teachers for special examination.

The laboratory is open for such examinations on Saturday mornings. On account of intervening holidays and press of other work, only thirty-three Saturdays were devoted to this work, and an average of four children was examined each day. This does not include twenty-two children from the Schools for the Deaf, who, for various reasons, were absent from their rooms when the regular examination was made, and were later brought to the central laboratory on various Saturdays.

These so-called laboratory cases are of two distinct types:

1. A few bright or normal children.
2. The large majority, backward or defective children.

1. Of the normal children there are two groups:
   a. Where curiosity or special interest in children prompted parents to ask for special examination, and a comparison of their children with the normal.
   b. Where the question uppermost in the mind of parent or teacher was, whether the mental stimulus of the school

room was not so excessive as to threaten interference with metabolism, and thereby affect the child's all round physical, and therefore, his mental development.

2. Of the backward children, a rough classification gives five more or less distinct groups:

a. Those subnormal mentally. Children ranging in mental strength from those unable to master the more intricate abstract school work, to cases of marked imbecility needing custodial care.

b. Those of delayed development; children very nearly normal but showing the mental or physical characteristics and development of children several years their juniors.

c. Those whose mental dullness has been caused by physical weakness or sickness.

d. Those whose failure in mental work is caused by sensory disturbances. In most cases, these were more or less simple defects of sight and hearing.

e. Those of unbalanced mental development—children who, while in a general sense not subnormal mentally, are peculiar or "unbalanced" in their mental development, being especially weak perhaps in one direction, and showing especial strength, in all probability in some other line of work.

Few or none of the children fall exclusively in any one of these groups, but in most cases they may be so classed, on account of the predominence of the symptoms.

The proportion of the different groups was about as follows:

1. Bright children.
   (a) For comparison with normal..... 5
   (b) To discover any possible weakness or danger..... 10
2. Backward children.
   (a) Subnormal mentality..... 31
   (b) Delayed development..... 9
   (c) Mental weakness caused by physical weakness..... 22
   (d) Sensory defects..... 38
   (e) Unbalanced development..... 11

Making a total for the school year.....126

A full statement in writing of the result of the examination in each case was made to the principal of the school attended by the child, and when thought advisable, a copy was sent to others interested.

With this statement of results, wherever possible, were included recommendations and suggestions as to the treatment of the child, both at home and in school.

In cases of subnormal mentality, where the child was of too low a grade to be cared for in the public schools, assistance was given in finding a suitable institution where he could be properly treated, or where the child could gain something from the public schools, without detriment to the normal children, special methods and devices were suggested for meeting his peculiarities.

In cases of delayed development, it was often possible to make an approximate estimate of the child's mental and physical status in comparison with the normal or average, and the kind and amount of work that might be attempted safely.

In cases of physical weakness or illness, suggestions as to possible pedagogical and home treatment were given, or a consultation with the family physician was advised. In very serious

cases a medical examination was given by Dr. W. S. Christopher, consulting pediatrician to the department.

Sensory defects were carefully examined, and when of sufficient gravity, the parents were urged to consult a competent specialist. In cases of peculiar gravity in regard to sight or hearing, a special examination was made by Dr. Frank Allport, consulting oculist and aurist to the department.

Children with unbalanced mental development are almost, without exception, cases for pedagogical treatment, and a correct analysis of the peculiarities of the child, and the difficulties under which he labors, is nearly coincident with the solution of the method of treatment.

WORK WITH THE CHILDREN IN THE SCHOOL ROOMS FOR THE DEAF.

A psycho-physical examination was given to each of the children in the twenty-three rooms for the deaf; a total of one hundred and sixty children.

One of the primary objects of this examination was to determine the grade of intelligence of the children attending these rooms, so that any possible criticism that might be made that they were not securing the best possible education which the Board of Education can give under the circumstances, might be forestalled.

As a result, the children fell naturally into four classes:

1st. Normal deaf children, who were average or above in native mental ability, but who possessed no power of hearing. It is for such children that the course of study in the Schools for the Deaf should be arranged.

2nd. Normal practically deaf children. Those of normal mentality, but with such slight power of hearing that they have never learned to use it, and therefore show most of the characteristics of deaf children, and are only approachable by the same methods.

3rd. Subnormal deaf. Children who are more or less defective mentally and also deaf.

4th. Subnormal with defective hearing. Children who are subnormal mentally, and whose hearing is very defective.

Practically it was found advisable to make another group, composed of children, some of whom could be classed in the other groups, but who for various reasons were distinctly detrimental to the work of the other children of these rooms and were therefor recommended for removal.

The children were distributed as follows:

A. Normal mentally—	
1. Deaf	101
2. Very defective hearing	21
B. Subnormal mentally—	
3. Deaf	17
4. Very defective hearing	1
Those detrimental to school and recommended for exclusion therefrom	20
Total	160

PHYSICAL EXAMINATIONS.

The department, assisted by a committee of physicians, selected from the Civil Service list of medical inspectors, conducted the physical examinations required by the Board of Education (see

proceedings of the Board of Education, 1899-1900, p. 467; 1900-1901, p. 582.)

The groups examined with number of each group is as follows:

1. Graduates of the Chicago Normal School entering the corps of elementary teachers.....192
2. Candidates for admission to the Normal School.....108
3. Experienced teachers applying for certificates to teach in the Public Schools..... 26
4. Applicants for certificates as family instructors in the Chicago Parental School..... 8

The data collected by the department from the physical examinations of the high school graduates who enter the Normal School, and of the graduates of the Normal School entering the teaching force, will in time, it is believed, furnish some valuable information for the Department of Physical Culture to take into account, and although the number of such examinations made to date is now quite considerable, being 1,238, nevertheless, it seems highly advisable to defer the publication of this data until the number of examinations will more fully justify any deductions that may be made, and recommendations that might be offered.

INVESTIGATION PEDAGOGICAL AND PSYCHOLOGICAL.

Introduction:

Every psychological experiment may be described with advantage in terms of stimulus or impression, and response or expression. Such a description means simply that a person is affected by something in some way, and that this effect is manifested in a particular manner.

In such a set of circumstances, conduct is induced or artificial, that is, the conditions are regulated so that some stimulus, or group of stimuli are selected for application by the experimenter and the resulting reaction of the subject is noted.

Again in thinking of reproduction or responding, one must bear in mind what is meant, whether it is the form in which the finished product appears, or the process as it goes on. This process may be relatively simple, or made up of a complex grouping of activities. Moreover, the process must be considered from two view points. First the overt external reproduction, which may be in one or other of the recognizable forms of expression depending upon the bodily organ which is principally exercised in the activity:

(a) Organs of Speech. Cries, Song, Language Oral.
(b) Hands. Gestures, Language Written. Instrumental Music, Picturing and Making: Drawing, Modeling, Painting, Sculpture.
(c) Body Entire. Dramatic Acting.

Second, the reproducing which may not be manifest; the distinctly mental, and this may be considered still further as either the direct which is immediate, or the translated or transformed, which is mediate.

The response may take effect at once, or after a relatively inappreciable lapse of time, in which case it is termed *immediate,* or an appreciable time may have elapsed before the overt evidences of the excitation are manifest, in which case it is called *delayed.*

Further, with reference to what is received—the stimulus side—every stimulus has attached to it more or less meaning,

but when anything presented to a person is relatively free from associations—comes as a bare entity, as for example the differences in pitch or the varying degrees in the intensity of light, it is for convenience termed non-significant or simple; when on the other hand it has associations with something one has met before in one's conscious experience, it on that account has meaning and is *significant* or complex. It is only under highly artificial conditions that "simple" stimuli are obtained, so that of necessity, school-room stimuli are always complex, and the experimenter in the school must deal with degrees of complexity.

If formal education is the conscious attempt to direct the impulses of the child to an end thought worth while by the teacher, the whole teaching process is then, a series of steps or stages of giving stimuli, and of getting responses, and according to the foregoing, this school-room work being subject to the same conditions in this respect as any experiment, may be classified on the basis of, first the character of the material presented, and secondly, the time between presentation and reproduction, in the following manner:

(a) Stimulus Simple, Response Immediate.
(b) Stimulus Complex, Response Immediate.
(c) Stimulus Simple, Response Delayed.
(d) Stimulus Complex, Response Delayed.

PEDAGOGICAL INVESTIGATION.

Three lines of investigation of pedagogical interest were carried on, viz.: Spelling, Reading and Writing, and in order that the psychological activities involved in these school studies may be more readily seen, it is advantageous to place them in the foreging scheme.

The work in Spelling centered around (a) Stimulus Simple, Response Immediate, and took the form of an examination of the children's power of reproducing the ordinary arabic numerals and other more non-significant stimuli, the direct object being to study the immediate-sense memory of the especially poor and of the exceptionally good spellers.

Reading centered about (b), (Stimulus Complex, Response Immediate) in the form principally of a study of the relative value of oral and silent reading for a particular purpose.

Further, under (b) Writing was studied with the primary object of examining the modifications of any standard system of writing which must be allowed to any individual pupil on account of motor peculiarities, natural or acquired.

The portion of the general scheme represented by (c) (Stimulus Simple, Response Delayed) was temporarily deferred because no such relation of stimulus and response obtained in the subjects under investigation, and because this kind of reaction does not represent the type of mind which it is desirable to develop in school work.

Spelling.

In a former investigation, see Report No. 3, the Department took up the study of the normal development of immediate-sense memory, i. e., where stimulus is comparatively simple and response immediate.

It was then found that the spelling of isolated words, when used as memory tests, produced results very similar to those gained by the use of lists of figures.

It was further indicated that the poorest spellers were in a

majority of cases, poor in immediate-sense memory, and good spellers usually had strong sense memories.

An elaboration of this latter point was attempted in the Marshall and Doolittle schools. Two groups of pupils were selected:

1st, those who were poor spellers and were at least fair in other studies, and those to whom spelling seemed especially difficult; in other words, those whose success in spelling contrasted unfavorably with their other work.

2nd, those who were good spellers and only fair, or poor in other studies, and those to whom learning to spell seemed remarkably easy.

These were tested by use of lists of figures in the same manner as in the above mentioned series of memory tests.

Also they were tested for visual memory by an arbitrary set of lines and angles, having no significance whatever.

The results fully confirmed the foregoing tentative conclusion. It proved true that while group 1 were as a rule, better all round students than group 2, yet in the matter of sense-memory, group 2 averaged over ten per cent better in the matter of sense-memory than group 1.

Further, the very large majority of the pupils in group 2 had visual and visual-motor memories stronger than their auditory or audio-motor memories, while in group 1, only a bare majority showed this preponderance.

In studying the school papers of these and other children, an attempt was made to classify several thousand of misspelled words. The following rough classification gave the per cents given in the various cases:

1. Where there seemed to be a defective mental image.
   (a) Where the pronunciation of the word was correct, (apparently a lack of a correct visual-motor image,) forty-six per cent.
   (b) Where the pronunciation of the word was incorrect, apparently a lack of both visual-motor and audio-motor images in a correct form, thirty per cent.
   (c) Where the word used was spelled correctly but the wrong word was used, (not always an error of spelling) sixteen per cent. This is a form of b, where the defective auditory image corresponds to some other word of the language, sometimes known and sometimes not known by the child.
2. Careless or inaccurate writing where the hand-motor coordinations seemed not sufficiently automatic for rapid work, two per cent.
3. Where a knowledge of one of the simple rules of spelling would have prevented the mistake, i. e., failure to substitute logical for mechanical memory, six per cent.

Reading.

The investigation of Reading took the form of a consideration of one of the functions of oral reading.

It is claimed by one class of educators that oral reading is never necessary or advantageous, except in the earlier years while a child is gaining a mastery of these conventional symbols. On the other hand, certain educators urge that oral reading can never be discarded without serious loss. This brings up the question as to what is considered as the end in view in oral reading; whether it is the sole or chief end of an oral lesson "to express thought in such a manner as to make others think it," or whether

oral reading has a place, and from the teacher's point of view, a very important function in assisting the child to get information or knowledge *for himself*.

It is about this latter function of reading that this investigation centered, and so the problem may be stated as a consideration of the comparative value of oral and silent reading for children of different ages as a means of getting information.

Two stories written for the purpose, simple, full of action and having reference to incidents common to the children's school life, were used for the experiment.

(Stories A and B are given below.)

Story A.

A little blue-eyed boy lived in a big red house, which stood in a broad street. Every day except Saturday and Sunday the boy went down the street to a large school-house. His teacher was very kind to him and the other children very nice, but the boy did not like to go to school, because there was a white-haired, old man with a wooden leg and a crutch who kept a peanut stand on the corner of the street between his house and the school. This man owned a little woolly dog that ran around and barked at persons who passed the stand.

One morning before breakfast the boy said he could not go to school because the dog would bite off his leg, and make him use a crutch like the old man. When he said this his brother called him a coward, his sister called him a baby, his uncle laughed at him, his father told him to be brave, but his mother only kissed him. After breakfast his father said that he would go a part of the way to school with him.

They walked down the street and when they came to the peanut stand it was shut up tight, and neither the old man nor the little dog was there. The next day the stand was moved away, and the little boy could go to school alone.

Story B.

Bessie was a brown-haired little girl, who lived on a narrow back street. Across the railroad track was a park with a pond where the gold fish swam, and a greenhouse, where they kept the flowers in winter. There were a great many children in Bessie's room at school, and the teacher was sometimes tired and cross. Bessie did not like to go to school because it was more fun to play in the park and watch the gold fish in summer, and play in the warm greenhouse in winter.

One evening Bessie's teacher called to see why she did not come to school. Her mother said that she did not know she was out of school, her brother called her a run-a-way and her father said they would have to shut her up. This scared Bessie so that she promised never to stay away from school again. For a long time she kept her word, but one bright spring morning she forgot and stopped to play in the park and watch the big white swan on the pond. The next day her mother made her stay in her room all day long. This was so lonesome that Bessie waited until there was no school to play in the park.

The teachers of the different rooms were asked to select the children in the order of their standing in reading work, irrespective of age or sex, and to send them, one at a time, to the private room used for the tests. On entering the room the age, birthday, room and grade were recorded, and the child was given

a clear typewritten copy of one of the stories and asked to read it over twice in succession to himself.

On completing the second reading, (having been previously supplied with pencil and paper) he was asked to write the story exactly as he remembered it. Later, the same children in the same order were again sent to the room, and being given the second story, were asked to read it orally twice in succession, and to write it as before.

To eliminate as far as possible the factors, skill acquired, embarrassment during first trial, and slight inherent differences in the stories, the order of giving both the stories, A and B, and the silent and oral reading tests, was interchanged, i. e., sometimes the oral test was given first, and sometimes the silent, again story A was read silently and B orally, and sometimes vice versa.

In one of the schools the experiment was varied still farther by having the children tell the story instead of writing it, a record being secured by stenographic report.

The results were calculated in the following manner. The story was divided into incidents and graded on the basis of the per cent of these incidents remembered and recorded. And while it is true that a story forms a complete whole for the person experiencing it, yet degrees of attention must be exercised to note the details or component parts. It may thus be called a test of discrimination under certain uniform conditions, or the grade of a child's activity in perceiving and calling up definite images. The name applied to the process, as well as the total or absolute result secured are matters of secondary importance, so long as conditions remain constant and give results that lend themselves readily to comparison.

TABLE I.

School Grade.	Total number Children.	Average age for grade. Yr.	Mo.	Method of Acquiring Information. Oral.	Silent.
III	41	9	1	75.61	24.39
IV	20	10	4	55.00	45.00
V	25	10	11	48.00	52.00
VI	23	12	4	39.13	60.87
	109				

From the above table (bearing in mind that the per cent might vary somewhat with increased numbers) it is seen:

1. That in the third grade or third year of school life, the per cent of incidents remembered after reading a story orally, is three times as great as that secured by silently reading a story of practically equal interest, and containing relatively the same proportion and order of kinds of ideas.

2. In the fourth grade the advantage still lies with the oral reading, although the difference between the two is very much less.

3. In the fifth grade the two are more nearly equal than anywhere else, but the silent reading is slightly in advance.

4. In the sixth grade the advantage has perceptibly shifted to the silent reading.

It will be seen, that when the reading is done primarily for the purpose of getting information, the general trend should be

from a relatively large use of oral reading in the lower grades, to a relatively large use of silent reading in the upper grades, and a premature forcing of the child to depend wholly upon silent reading, will cause a distinct loss of time, if nothing worse.

It must likewise be borne in mind, however, that there are not a few children in the lower grades who, on account of early training, or other possible reasons not yet investigated, secure more information by means of silent reading, and conversely, there are always some children even in highest grades, who perhaps more on account of native peculiarity than of training, can get more definite, clear and workable imagery by means of oral reading.

The obvious conclusion seems then, that the teacher must keep in mind those two supplementary processes, and while the general trend in school room work, from oral reading to silent is in line with the natural order of development, nevertheless, the teacher must bear the responsibility of saying when a class or an individual child is capable of using predominantly or exclusively, either method.

It is not so much a conflict between two specific methods of reading or teaching reading, as it is a matter of taking account of the previous training and mental type of the child, and making these two methods co-operate or supplement each other when it is a matter of the child's getting the contents of the printed page.

This relative decrease from grade to grade in the number of children who are able to secure more ideas through oral reading, and the corresponding increase in the number able to secure more ideas by silent reading, may be interpreted to mean an acquired skill in handling the conventional symbols of our civilization, letters, words, figures, signs, which means that the activities connected with these have become so fixed in our organization, that they are relegated to the background of conscious life; but even though this is true, it means that oral reading in school room work, especially in the lower grades, is much more valuable as a means for the child to get information from the printed page, than as a test given by the teacher to determine whether the child knows what he reads.

It is in the use of oral reading that there is seen the most flagrant violation of the principle that the recitation should be only secondarily a test of the amount of the child's knowledge, and should be primarily, a means of getting and perfecting the organization of this knowledge.

Writing.

It is a common observation that a person's handwriting changes as he matures from the more or less stereotyped form learned during school days, to the characteristic scrawl of the adult. On account of this distinct change, any attempt to foretell and define its path of direction has a specific value for teachers of writing.

Although a form of handwriting is prescribed in almost all school systems, there is considerable variety as to the age about which it is considered safe to allow the handwriting to take care of itself, and a marked agreement in that there seems to be no direct conscious attempt to furnish the proper conditions and guidance for individuality in this artificial mode of expression to develop.

In order to study the variations or the characteristics which differentiate one's natural handwriting from the mere drawing of letters, it was found necessary to distract attention as much

as possible from the writing movements. With this end in view a short paragraph from a story of animal life was written on the blackboard by the teacher. In order that there might be no hesitancy during the time the writing was being done, the children were asked to read the paragraph over carefully one or more times, so as to familiarize themselves with the ideas.

Having been previously supplied with paper they were told to begin to write at a given signal, and stop at a signal, and to write rapidly enough to complete the copying of the paragraph within a given time. The time was varied slightly from grade to grade, but averaged about three minutes for the forty-nine words containing two hundred and two letters in the paragraph. If any one completed the task before the time elapsed he was told to turn his paper. A majority finished within the time.

The second test, using a sentence containing nineteen words of eighty-three letters, was given in much the same way with this exception, that instead of being asked to write rapidly, the pupils were assured that ample time would be given, and requested to write in "their very best hand."

These tests, continuing from January to the end of March, 1903, were given to the pupils from the fourth to the twelfth grade, inclusive. Below the fourth grade it was very difficult to distract the child's attention from the writing as writing, on account of the fact that a relatively large per cent of the children draw the letters or words, rather than write.

It has been convenient to refer to the first of these tests as the rapid test, and to the second as the slow test.

In compiling the results it was found convenient to make three classes: first, the vertical, secondly, the varying degrees of slope to the left termed backhand; thirdly, the different degrees of slope to the right of the vertical called Spencerian or forward slant.

When the pupil used the same slope in the rapid and slow tests, his writing was termed *constant;* when on the other hand, the slope of writing in the two tests changed, as for example, vertical in the slow test and Spencerian slant in the rapid, his writing was considered *variable.*

The following table shows the distribution of the three constants above described, and the five combinations of variables:

TABLE II.

CONSTANTS.

Grade	Spencerian Slant.	Vertical.	Backhand.
IV	28	61	34
V	68	127	99
VI	56	103	95
VII	42	80	53
VIII	52	46	21
IX	22	2	7
X	19	..	5
XI	17	1	6
XII	18	1	4
	322	421	324

TABLE II. (Con.)
VARIABLES.

Grade	Sp. Slant Rapid. Vertical Slow.	Back Rapid. Vertical Slow.	Vertical Rapid. Back Slow.	Sp. Slant Rapid. Back Slow.	Vertical Rapid. Sp. Slant Slow.	Total.
IV	24	6	5	1	1	160
V	39	22	18	25	3	401
VI	42	13	15	11	1	336
VII	34	4	5	9	2	229
VIII	43	7	1	7	2	179
IX	1	2	..	..	..	34
X	1	..	..	..	..	25
XI	..	2	..	..	..	26
XII	1	1	..	..	..	25
	185	57	44	53	9	1415

Now the constants are the least interesting of these groups or combinations. Those in the vertical form, in the majority of cases, mean that the habit formed under instruction in the vertical system had not been overcome by any personal peculiarities of the child. Those in the Spencerian slant and backhand mean a deviation from the vertical standard, due to the child's position at the desk, or that the habit of vertical writing had not been fixed, either because the teachers had not insisted on rigid adherence to the prescribed vertical form, or on account of the strong motor peculiarities of the child.

When we consider the variables, several important facts appear. Of the total number using different handwriting in the two tests, seventy per cent wrote a vertical hand in the slow test, while in the test for rapid writing, sixty-eight per cent of these same children used a more or less pronounced Spencerian slant, and sixteen per cent adopted backhand of more or less marked slope.

This would seem to indicate that where habits of writing are not so firmly fixed, as are shown in the so-called constants, a majority of children in writing "carefully" use the form of handwriting which they have been taught, but when by any means their attention is distracted, they resort to that form of writing which most nearly expresses their individual type of motor reaction.

The following table may be of interest in showing in a direct way the per cent of children taught the vertical system who do, and the per cent of those who do not adhere to this system from the fourth to the twelfth grade of school work:

TABLE III.

Grade.	Number Examined.	Per cent writing Vertical.	Spencerian Slant Per cent.	Backhand Per cent.	Total P. C. leav'g Vertical.
IV	160	41.7	33.3	25.0	58.3
V	401	37.0	32.8	30.2	63
VI	336	35.4	32.4	32.1	64.5
VII	229	38.0	37.1	24.8	61.9
VIII	179	27.3	57.0	15.7	72.7
IX	322	27.9	55.3	16.8	72.1
X	136	19.8	61.8	18.4	80.2
XI	157	17.2	69.4	13.4	82.8
XII	95	5.3	84.2	10.5	94.7

There remains the question whether this variation from the prescribed system means an actual growth of individuality in the handwriting of the pupils, or represents a decay in interest resulting in careless and irregular writing.

Since in the grades, the course of study prescribes copy book work, and a definite fixed standard for writing, namely, the so-called vertical system, and the teachers to a greater or less extent follow the course of study, it was thought well to consider only papers from the high schools in making a closer inquiry in regard to the growth of individuality.

In order to avoid all possibility of the pupils being aware of the purpose in mind, and so influencing the result, theme papers and other exercise papers were obtained from the teachers and used in this compilation.

The papers of each grade were carefully examined, and all those showing an adherence to conventional forms (vertical or otherwise), together with those showing undeveloped or irregular writing, were grouped together, while all those showing any peculiar characteristic individuality of style, which at the same time possessed regularity and consistency throughout, formed a second group.

The following table shows the per cent of pupils in each grade of the High School who show marked individuality:

TABLE IV.

INDIVIDUALITY IN HAND WRITING.

Observational work on examination papers of pupils of the John Marshall High School.

Grade.	Number Examined.	Showing individ'y Per cent.	Not showing individ'y Per cent.
IX	288	49	51
X	111	63	37
XI	128	68	32
XII	70	70	30

It would seem, then, that not only do the pupils tend to vary from the prescribed system or standard, but such variation means in a majority of cases a development of a personal, individual handwriting, and the relatively large per cent (49) found in the ninth grade would indicate that this development began somewhere below the high school.

In order to study the most marked types of handwriting more in detail, a special piece of apparatus was devised called the Graphometer, consisting of a plain, neat wooden tablet, size 12 inches by 13 inches, in which was embedded a circular disc of insulating rubber whose radius was 21 m. m. this being very nearly the length of the longest letter (f), of the orthodox copy books.

The pen which the child used resembled a school lead pencil, with diameter 10 m. m. The aluminum point of this pencil was made to fit neatly in a groove cut along a radius of the rubber disc, so that it could be moved freely from the center to the circumference. Through the holder an insulated, flexible light wire was drawn, and connected with one pole of an electric recorder. The friction of the pen in movement was inappreciable, and the arm was allowed free movement. The electric circuit was closed by two contacts, one at a brass pin at the center of the disc, and one at a brass circle which formed the circumfer-

ence of the same, so that every time the pencil was moved the full length of the groove, a contact was made and recorded. Moreover, the disc could be turned about the center pin so that any angle of deflection of the groove could be secured.

At a given signal he was told to begin these writing movements, i. e., to move the point back and forth the length of the groove, and at the end of thirty seconds, the signal was given to stop.

The Graphometer was placed before him in the so-called middle position, and the disc turned so that the groove made an angle corresponding to one of the slopes of writing examined. The position of the arm and bodily attitude were likewise determined. The groove was then turned successively to the two other slopes examined, and records were secured in the same way.

In addition, the regular motor ability tests were given to each child tested on the Graphometer, in order to determine the relation of the child's rate of rapid writing in his most suitable slope to his voluntary motor control.

By an examination of the child's writing in the rapid test it was easy to discover what slope he most naturally used in trying to write rapidly. This slope was compared with the results of the tests on the Graphometer. In almost every instance, the record on the machine which showed the greatest speed, was the one which corresponded most nearly to the general slope of the child's writing in the rapid test, i. e., where there was a reversion of slant in writing fast, irrespective of the slope when the object was to write beautifully, the same slope on the machine showed the greatest speed.

This indicates pretty clearly that slope in writing is more a matter of the child's anatomical structure and muscular coordinations than of individual caprice on the child's part or instruction on the part of the school.

Moreover, before each child was examined on the machine he was observed in the act of writing. By this means, in addition to the data already collected with reference to the variations of slope in the rapid and slow tests, the angle at which the paper was placed with reference to the front line of the body, the arm movements, finger movements and bodily attitude were determined. In each test given the machine was turned around on the desk to take these factors into account.

In every instance, the slope of the rapid writing test, and the number of degrees variation from this, when the aim was to write a good-looking hand, proved to be the same angle that the paper was turned on the desk by the writer, while his hand was placed at right angles to the lines of the paper. For example: if the slope of the rapid test, as determined from the lines written, proved to be 30 degrees backhand, or 30 degrees Spencerian slant, while the slope of the lines written with speed, as the end in view, was vertical, the paper was turned on the desk by the writer until the angle made by the lines of the paper with a line drawn horizontal to the front surface of his body was 30 degrees.

This was further verified in each instance by the machine. This indicates that all writing is relatively a conforming to the easiest and quickest method of moving, and that where the slope of the written letters remains unchanged in these two tests, this constancy is often secured by turning the paper.

Moreover, the fact that the swiftest movement on the machine

was secured when the groove was horizontal (and slant in writing most nearly approaches this), shows that any attempts made by the writer to get this advantage of his arm and wrist movements was an instinctive tendency, to get in the line of easy movement and control by turning the paper though the finger movements persisted in the direction which was vertical when considered from the straight middle position.

Suggestions.

1. It might be well to teach children in the lower grades some good standard form of letters and combination of letters.
2. Somewhere during the third or fourth grades the fixed models of written forms should be gradually withdrawn and the majority of the children be allowed to develop, to a certain extent, their own hand.
3. In the lower grades while the forms are being fixed, legibility and regularity, rather than speed, should be the standard, and care taken that the children be not given too much writing. In the upper grades, after the individuality of the handwriting has become fairly well developed, legibility with speed should be the ideal.
4. To the principal of the school or the teacher, the decision of the question should be left, whether a child's handwriting is sufficiently well developed or fixed to warrant being excused partially or wholly from formal practice, or copying from models.
5. There are certain children who, on account of motor defects will in all probability, never be able to develop individuality in writing, and in some cases may even be unable to adequately control the writing activities. All those children, especially the latter, should be taught some legible system of lettering and permitted to "draw" the letters.
6. The particular system prescribed for the lower grades must be decided by considerations of simplicity, legibility and the like, and the prevalent slant adopted by a majority of the pupils in the later years is not necessarily the best to present to the learner when the type or model of the letters is being fixed, so that the prescribed system is a matter of relatively secondary importance.

It is an injustice to the child to impose a system of handwriting upon him, and force him to adhere to it through his growing years, at the cost of not only suppressing his individuality in this acquired mode of expression, but also at the sacrifice of his time and the mental fluency that comes with the ease which accompanies a mode of expression fitting the individual's characteristics. On the other hand, it is an injustice, not only to himself, but to others to allow so great a divergence from conventional forms as to make his writing illegible. The prescribed system will furnish a model, which acting as a conserving force, will prevent too great a divergence because of the unconscious reference and comparison of his finished product at any time to this model which has been incorporated in his writing habits.

PSYCHOLOGICAL INVESTIGATION.

The distinctly psychological features of the investigation centered around (d), stimulus complex and response delayed. (See p. 7.)

This took the form of an inquiry into the comparative growth of the power to recall and record a series of incidents which the children had previously dealt with. The material for this experi-

ment was handily secured by utilizing the paragraph from the story which was used in the rapid-writing test. This was brought about by having the children prepare themselves in the same manner as when the writing tests were taken, with the exception that when they were all in readiness for the test to be given they were asked to reproduce what they remembered of the story already given.

Now, it must be borne in mind that in the presentation of the original writing-test, as soon as the children had become thoroughly familiar with the ideas of the story, by reading it over twice in succession, their attention was distracted during the time of expression by their being asked to write down the incidents as quickly as they could under the conditions of the experiment. Then, as soon as the time limit had elapsed, the story was erased from the blackboard, and in no instance was a child aware that he would be called upon to reproduce and record it. Moreover, the slow-writing test was given as soon after the rapid-writing test as could be arranged. This, together with the fact that six days of school work had elapsed and Saturday and Sunday intervened, before the children were asked to reproduce the story, may have accounted for the relatively small sum total of ideas retained during the interval, but so long as the conditions of experimentation remain constant, the comparative growth of this type of memory from grade to grade, is the important consideration.

The following table shows the limits, from grade IV to grade VIII, inclusive, between which the per cent of ideas reproduced falls, for the average or normal group of children. To illustrate: in the fourth grade, 41.5 per cent is the average number of ideas remembered by children of that grade. Each child examined varied more or less above or below this average or normal, and 4.63 per cent is the average of all the variations in this grade. Now, by adding 4.63 per cent to, and subtracting it from the normal 41.5 per cent we obtain 36.9 per cent and 46.1 per cent. which represent the limits between which the large majority of the children of this grade would fall.

TABLE V.

Grade.	Number Examined.	Average Number of Ideas Reproduced.	Column 3. Expressed in per cent.	The average of the individual variations from the average of the group.	Column 5. Expressed in per cent.	Limits between which per cent of ideas reproduced falls, for the normal or average group.
IV	...128	2.49	41.5	.278	4.63	36.9—46.1
V	...269	3.19	53.2	.345	5.75	47.5—59.
VI	...310	3.49	58.2	.401	6.68	51.5—64.8
VII	...201	4.25	70.8	.248	4.13	66.5—75.
VIII	...103	4.65	77.5	.291	4.85	72.6—83.3

TABLE VI.

Comparison of Audio-visual-hand-motor Memory for Numerals with the Memory for Ideas.

School Grade.	Content Remembered in Per Cent. Numerals.	Ideas.
IV	55.9—63.3	36.9—46.1
V	63.3—68.8	47.5—59.
VI	68.8—71.7	51.5—64.8
VII	71.7—79.3	66.5—75.
VIII	79.3—81.1	72.6—83.3

From this table it is apparent:

1. There seems to be no evidence of a definite "memory age." This is true irrespective of the character of the content remembered.

2. The average increase in memory for significant content is greater from year to year than the memory for non-significant matter.

3. The memory for ideas increases more rapidly in the upper grades than the memory for numerals, which seems to indicate that it is more susceptible of cultivation, and that while the immediate sense-memory increases with age and experience until between thirteen and sixteen years, there is after this period a marked decline in the rate of increase amounting to almost complete cessation. (See Report No. 3, of the Department.)

4. The parallel growth of the two types of memory is very evident, and while the test given for the reproduction of ideas more nearly approaches the functional use of memory, the relation which the memory for numerals bears to it, furnishes a convenient index which may be used in estimating the strength of this mental function in any individual.

Note.—Acknowledgements are due and are hereby tendered to those Principals and Teachers of the Chicago Public Schools who so willingly co-operated in the various lines of work.

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